THE ROLE OF CONSCIOUSNESS AS MEANING MAKER IN SCIENCE, CULTURE, AND RELIGION

by Patrick A. Heelan

Abstract. Two hundred years ago, Friedrich Schleiermacher took critical issue with Immanuel Kant's intellectual notion of *intuition* as applied to human nature (Wellmon 2006). He found it necessary to modify—"hermeneutically," as he said—Kant's notion of anthropology by enabling it to include as human the new and strange human tribes Captain Cook found in the Pacific South Seas. A similar hermeneutic move is necessary if physics is to include the local contextual empirical syntheses of relativity and quantum physics. In this hermeneutical revision the synthesis is formed around the notion of a Hilbert Vector Space as the universal grammar of physics, adding to it the dynamic of the Schrödinger equation, and representing empirical "observables" by projection operators that map the subspaces of definite measurable values. Among the set of observable projection operators, some pairs share the same subspace, commute with one another, and share a common laboratory setting. Other pairs do not share this property and are described as being mutually complementary. Complementary symmetries introduce into the discursive language of physics the commonsense notion of contextuality. The new synthesis, proposed by Eugene Wigner, John von Neumann, and (in his own way) Paul Dirac, brought physics into the community of common language and established it as a work of general human achievement.[1]

Keywords: concepts; consciousness; context; Albert Einstein; experiment; geometry; grammar; Martin Heidegger; Werner Heisenberg; hermeneutical; Hilbert Space; Edmund Husserl; Bernard Lonergan; perception; philosophy; physics; quantum; religion; Space; symmetry; synthesis; theology; theory; Time; transcendental; Eugene Wigner.

Patrick A. Heelan is William A. Gaston Professor of Philosophy, Georgetown University, Washington, D.C. 20057-1133; e-mail heelanp@georgetown.edu.

[*Zygon*, vol. 44, no. 2 (June 2009)]

Karl Pribram, George Farre, and I have been meeting regularly for a number of years to collaborate on current topics that cross the borders between the natural sciences, particularly physics, physiology, and neuropsychology, and the cultural sciences of philosophy and religion. Our purpose has been to present a rational sketch of how science and religion may be seen in a coordinated non–conflict-ridden display rather than in the way they are often presented today. All three of us belong to the Judaeo-Christian tradition, but our church affiliations are not formally involved in these presentations. I am a physicist and a philosopher and also a Jesuit priest of the Roman Catholic Church, and I endorse Vatican Council II's "Closing Message" addressed to scientists; in the words of the Council, they too are "seekers after truth," and "your truth is ours" (*Documents of Vatican II* 1966, "Closing Messages," 730–31).

I am a cross-disciplinary scholar, with good connections across cosmology, quantum physics, philosophy, and Christian theology. I studied relativistic cosmology (1946–48) with Erwin Schrödinger at the Dublin Institute for Advanced Studies. Later as a post-doc (1960–62) at Princeton I studied high-energy quantum physics with Eugene Wigner, and later (1962–64) I visited frequently with Werner Heisenberg in Munich while writing a book on his philosophy of science (Heelan 1965). Out of my many discussions with these three Nobel Prize physicists I developed an interest in the fundamental role all three gave to religion and to the role of human consciousness in physics.[2]

Of the three physicists mentioned, Wigner influenced me most, not by public exhortation but by his scientific and cultural intuitions. Looking back on his life as a physicist, he told his chronicler, Andrew Szanton:

> My chief scientific interest in the last twenty years has been to somehow extend theoretical physics into the realm of consciousness. . . . Consciousness is beautifully complex. It has never been properly described, certainly not by physics and mathematics. It is shrouded in mysteries. And what I know of philosophy and psychology suggests that these disciplines have never defined consciousness either. (Szanton 1992, 309)

Human Consciousness as "the Governor of Mental Life"

What is human consciousness? Few cognitive scientists are willing to define it. Why? Although it certainly processes information signals like Deep Blue, the IBM computer chess champion, it does in addition have sensory experiences, produces new insights, tests for relevant truth in the world, and makes free value-laden decisions on the basis of the information it gets. The best account of consciousness, I think, is given by the distinguished Canadian neuropsychologist Merlin Donald, who defines it as "the Governor of Mental Life" (2001, 45–91) that functions as the meaning maker and manager in science, culture, and religion. About this he wrote:

> . . . what consciousness is really about, at least in the human species . . . is much deeper than the sensory stream. It is about building and sustaining mental models of reality, constructing meaning, and asserting autonomous intermediate-term control over one's thought process, even without the extra clarity afforded by the explicit consensual system of language. The engine of the symbolic mind, the one that ultimately generates language to serve its own representational agenda, is much larger and more powerful than language, which is after all its own (generally inadequate) invention. (2001, 75)

Meaning making or meaning constitution—otherwise called intentional activity—is the making of concepts, predications, judgments, and practices. These are four essential phases in the human process of meaningful activity. In this I follow the great tradition of hermeneutic and phenomenological thinking of Edmund Husserl ([1952] 1989; 1966; [1901–1913] 1970; [1954] 1970; for an excellent guide, see Welton 2000), Martin Heidegger ([1950] 2002; [1954] 1967; 1962; 1982; [1989] 1999; 1995; 2002), and Maurice Merleau-Ponty (1962), all of whom are linked with the ancient Greek and scholastic tradition through Bernard Lonergan's reflection on the transcendental process of meaning making and the importance of what he calls interiority (Lonergan [1957] 1992; [1972] 1990), that is, the interior awareness of one's own consciousness as the governor of one's mental life.

Hermeneutics as the Universal and Transcendental Process of Meaning Making

The universal and transcendental process of meaning making is a circular or cyclic process that has been called the hermeneutical circle (Heidegger 1962; Lonergan [1957] 1992; 1970). Each circle, or cycle, follows a sequence of four phases, each phase improving access to the insights that are sought; each cycle can return to its origin to expand what it learned the first time around. Each repetition of the hermeneutical cycle revises and improves the previous cycles of inquiry, and the repetitions will continue until the basic queries have been sufficiently explored.

I explain below the four phases of the hermeneutical circle by referring to my research on the geometry implicit in Vincent van Gogh's 1888 painting *Bedroom at Arles* (Heelan 1972; [1983] 1988).

Experiencing. The initial phase of cognitive inquiry begins when attention has been drawn to some "given" experience that raises a question of a priori interest to the inquirer. I ask: "Why does van Gogh's painting of his Bedroom at Arles look and feel so real despite the 'unnatural' perspective of the walls, bed, and floor?" I add my version of James J. Gibson's question: "Why did so many young air pilots in World War II kill themselves when trying to land their planes?" (see Gibson 1979)

Theory Making. The second phase of inquiry is the choice of a heuristic that leads to an insight into a likely hypothesis or theory that relates the initial experience to a circle of other experiences and environmental conditions. I ask: "Could it be that the realistic mood generated by viewing van Gogh's painting is a consequence of a 'natural,' as opposed to the scientific, use of perspective in painting the world?" In my Gibsonian narrative, Gibson asked: "Is it possible that the failure of pilots to land their planes successfully had a similar source—that 'natural' perspective contradicts the scientific Euclidean perspective of space?"

Testing Theory. The third phase is one of testing and passing judgment on the proposed theory. I suggest: "Let us study the history of human vision and the history of artists' problems with scientific perspective. Let us study also the evolutionary history of visual meaning making to find whether the 'natural' meaning humans give to purely visual space is different from the meaning that Euclidean science and technology gives to spatial environment."

Deciding. The fourth phase is decision making on the basis of the theory, let us suppose, as newly accepted. New practices follow the new theory; these practices are local and performed with measuring instruments in a planned and protected environment, such as a laboratory. I summarize as follows the conclusion of my own research: Evidence from van Gogh's letters and other studies (see Heelan [1983] 1988, chaps. 4–6 as in the references to Arnheim 1974) support the view that van Gogh deliberately designed his own perspective frame to eliminate Euclidean depth control from his painting. I summarize as follows the conclusions of my own research: that human vision was shaped by evolution to aid ground living only and not to flying in a plane above ground. Hence control of a plane on landing should not be guided by natural vision but should be handed over either to onboard instruments or to the airport tower. I presented these conclusions to Gibson at M.I.T. in 1974 on the occasion of the celebration of his 70th birthday. He agreed with them, for it was he who introduced the system of visual signs on the ground that pilots are taught to follow in landing a plane if they are forced to do so without the help of instruments or the airport tower (see Gibson 1979).

The hermeneutical circle is the structure of the transcendental rationality of the human species (Heelan 1994; 1998). Self-awareness of this transcendental rational dynamic function constitutes what Lonergan calls the rare virtue of interiority. Lonergan has shown that there is a history to the interior phases of inquiry present in ancient and modern writers, from Plato and Aristotle to Thomas Aquinas and up to the present. Such a sense of self-in-the-world is deeply reflected in the writings of Husserl's phenomenology, particularly in his later works, and in Heidegger's *Being and*

Time ([1927] 1962). Heraclitus once said that human consciousness loves to hide itself—a sentiment shared with cognitive scientists, philosophers, and other scientists. In recent times, it is echoed in Heidegger ([1927] 1962), Pierre Hadot (2006, chap. 1), and other philosophers. Interiority makes deep demands on philosophers and cognitive scientists concerned with the rationality of the natural sciences and of religious faith.

The Governor of Mental Life and Meaning Making

The Governor of Mental Life—human consciousness—makes meanings of different kinds. Let us look at meaning making in the natural sciences. The different kinds of meanings include concept formation—for example, of the concepts of Space, Time, and Measurement. Are concepts made by a "moving" likeness of remembered instances or by an unchanging "eternal" abstraction? Our concepts are represented by media of communication. How are media and the messages they carry distinguished from one another? Regarding theory formation, what is the role of mathematics? How are the grammar and the lexicon of science distinguished in use? Is mathematics the universal grammar of science?

Theory testing leaves a residue of meaning uncertainty because of several factors, such as the subject's freedom of choice in ways of universalizing judgments or principles because of the contingency of empirical evidence. The contingency of empirical evidence is a function of the contextuality of the evidentiary horizon, such as, for example, the laboratory, the social demand for cultural and institutional agreement, and the historical dimension of languages, practices, cultures, and institutions. These all lead to the modalities of possibility, probability, and uncertainty and the need for continual reviews and revisions that implicate the social, cultural, and historical aspects of natural science as well as the philosophical and theological culture of the local environment. The natural sciences are not finished products. Ethical, aesthetic, and religious meaning making, as well as other value-added aspects of decision making, condition the choices affecting both the inquirer and the circumstances of the inquiry.

The canvas is a large one. However, I do not intend to cover all of it. I want only to address some aspects under each heading.

Concept Formation and Evolution. Descriptive concept formation is part of the general story of human evolution. What is it about concept making that human nature hides from consciousness in the story of evolution? Human infants do not come into the world conscious of knowing anything about it; they acquire knowledge through the extraordinary abilities with which they are born. These abilities include learning from those around them by "reading their minds"; communicating by mimicry and then by language; exploring their environment for perceptual content and expressing this meaning in the language of the family or caregivers; and collaborating with their family and caregivers who, by their natural authority, give them their local world as well as the means to share it and express it in language as members of a human community (Tomasello 1999).

The function of perception for a child is to enable her to negotiate her way in her home and local environment. This function has already been shaped by past evolutionary and historical cultural processes. Consider, for example, human vision. A child born today has a native stereoscopic visual system that is specialized to coordinate vision with the physical movements of arms, hands, fingers, and legs, because young people, like early human beings, have to be able to navigate with these bodily limbs safely in their local environments.

Visual Space. The visual space apprehended by a developing child in modern times is shaped by these same visual and somatic functions in coordinating hands and eyes and limbs that early humans received from their biological ancestors. This early human vision is constituted by a nearby, virtually Euclidean, zone that Rudolf Arnheim (1974) called the Newtonian Oasis and a far zone that surrounds it where the depth of field diminishes rapidly to zero (Heelan 1972; 1983; [1983] 1988, Part I and Appendix; Luneburg 1947; 1950). In theory, the non-Euclidean geometry of natural human visual space can be derived a priori from stereoscopy. The characteristics of this general structure have been confirmed by testing (Luneburg 1947; 1950; Heelan 1972; 1983; [1983] 1988).

The account of vision given above is not incompatible with the dual visual neurological pathways that neuroscientists have found (Jacob and Jeannerod 2003; Jacob 1988; Pribram 1991). Scientific research in this area tends to overlook the dual role played by light, for light is a medium that also carries a message. This double function is often ignored and the message mistakenly identified with the medium, such as when the objects of visual experiences are identified with the photons of light falling on the retina. Photons are only the media that carry a message—generally, information about illuminated bodies in the environment. Human vision uses this information to manage hand, eye, and limb coordination (Berthoz and Petit 2008). The light-structured space of rays or photons is in Euclidean scientific space; the message they carry, however, is "read" hermeneutically by human visual consciousness and is present to the viewer in a curved space, the curved space inherited from primitive humans. Modern scientific Euclidean space lacks a local zone of privileged human interest; "natural primitive" vision then represents surrounding bodies in a hyperbolic family of curved three-dimensional Riemannian Spaces (so called after Bernhard Reimann, the mathematician who first studied them). I have shown that they privilege the zone of human eye-hand collaboration (Heelan [1983] 1988). The family of such spaces, as I have said, can be inferred a priori from the theoretical treatment of binocular stereoscopic vision and has been confirmed by many experimental tests—but not, however, without some controversy related to the role of consciousness in constructing an "objective" world (Heelan [1983] 1988).

Concept Formation of Perceptual Objects. The process of perceptual recognition produces a descriptive concept that is associated with a lexical name and standard sensory medium of representation. How is the concept that goes with that lexical name constructed? The process clearly is an embodied one. A Husserlean phenomenological analysis (Jacob and Jeannerod 2003; Jacob 1988; Pribram 1991) would describe its intentional constitution as the creation or recognition of a symmetry (an invariant and repeatable pattern or similarity) present in a set of individuals "given" to perception in the flux of sensations by the learned human art of visual interpretation (Cassirer 1944). In some circumstances, the symmetry may already exist in memory from previous engagements with the subject matter, or it may be in the course of being constructed as a certain learned norm in the socially prestructured world into which the child is born. Learning of this kind is an interpretative process structured by both nature and culture (Tomasello 1999). It is more primitive than, say, the reading of a text, because the reading of semiotic textual signs already presupposes an acquired cultural resource from which to draw.

The structure of a perceptual concept, then, is having an intuited meaningful symmetry within a fixed local enframing context of perceiver and perceived that persists despite changes in spatiotemporal perspective or among the diverse exemplars displayed; the meaningful sameness is both functional and spatiotemporal (Cassirer 1944). One function of the Governor of Mental Life is to reveal an intuited meaningful symmetry that is "given" in perception as "found" in a flux of local embodied sensation within a local enframing context of perceiver and perceived. The mathematical structure in this account supposes an intuited group-theoretic symmetry in what is made present in the sensory flux by "interpretation" as something that is preserved under group-theoretic transformations affecting the local situation of the perceiver, the perceived, and a standard enframing context. An individual exemplar belongs to its usual cultural symmetry set; however, it is not "given" with necessity, because each exemplar is in some way different from all other exemplars. Because of these differences any individual exemplar can be counted as an exemplar of some other symmetry than that of its usual cultural description. A "boot," for instance, can become on some appropriate occasion a hammer, or even a political statement!

Concept Formation by Measurement. What is present in a measurement is a numbered datum. Heisenberg told me that Albert Einstein objected to his assertion that the quantum uncertainty relations were "real" by claiming that a measure number, or numbered datum, is related to that which is measured, as the number on a cloakroom ticket is to your overcoat (see Heisenberg 1971, 62–69; Einstein 1950, 64): The ticket number tells you nothing about your overcoat—or whatever may be hanging on that numbered hook in the cloakroom! The numbered datum is just a messenger that carries a message, and its message is: This cloakroom is its niche. Nothing else is communicated. Likewise the message of the numbered datum in the laboratory is its niche; nothing else is communicated—not its shape, size, color, or function, nor perhaps should one suppose that it has any of these. An act of measurement, then, is a perceptual act, but only to the extent that the observer is "embodied" in the laboratory bench setup. Merleau-Ponty would say that such a case is paradigmatically exemplified in the way a blind man is embodied in his cane, inhabiting it with his bodily sensibility (Merleau-Ponty 1962; Heelan [1983] 1988).

The Role of Theory and Laboratory Context in Meaning Making

Pure Mathematics, Anschaulichkeit*, Meaning Uncertainty*. Pure Mathematics is the pure science of meaningful structure. It is a set of defined formal relationships among a lexicon of postulated mathematical entities, whether numbers, figures, or patterns, that inhabit the space of the mathematical imagination, algebraic or geometrical. These mathematical entities exist only as intuited—in German, *anschaulich*—in the aesthetic space of the mathematical imagination.

Theoretical Physics and Mathematical Models in Physics. The essence of modern science historically is the mathematizing of the measured world. Scientists and philosophers of the classical school incautiously adopted from the Newtonian period the metaphysical view that the mathematical continuum is a real continuum occupied by movable atomic elements. Mathematical points, lines, and surfaces are not empirical bodies in the world; they are pure—nonempirical—elements defined within mathematical intuition by algebraic or geometric functions. In relation to the real, sensible, world, an intuited representation in the imagination is no more than a semiotic element, though pure (nonempirical); it is like a word of text or a syntactical structure of grammar. However, it can be used in a predication of experience the way a pure concept is used, and such a predication instantiates the mathematical representation and creates a physical exemplar.

How is this done? A theoretical computation is a function in the field of mathematics. The classical mathematical field is the field of *Anschaulichkeit*, the field of structures and functions intuitable in Space and Time as imagined.[3] This is the workplace where mathematical operations take place, where its formulas are developed, and where they are applied to pure mathematical entities. Mathematical formulas can be used to symbolize operations in the real, sensible, world, usually through the instrumentality of measurement, which associates a network of measure numbers with a network of related named physical properties. Through such a mathematical model aspects of the real empirical spatial and temporal world of human culture can be ordered and controlled (Ryckman 2005; Heelan 2003; 2004).

As a function related to human evolution, mathematical intuition is a cultural development of the primordial human ability to see, hear, touch, taste, and feel the world perceptually by recognizing recurrent patterns in the sensory flux that can be subjected to instrumental measurement in a laboratory. These patterns can then be represented mathematically, and the mathematical representations can be given a theoretical name and shared with others. These theoretical entities are messengers that point to the empirically real of the laboratory. The essential evolutionary function of mathematics is then related to the organization of perception—its aesthetic and its practical use. Although it has a transcendent aesthetic beauty for professional mathematicians, it is not a divine language, as some distinguished physicists have speculated. It is a very human language, closely connected with the way we embodied humans organize our world by recognizing and naming recurrent patterns amid evident differences.

Among the basic organizational skills humans have is the native ability to find patterns in the sensory flux to which we assign a meaning that is public, objective, and shared through language with our cultural community. (For the grammar of scientific discourse, see Rheinberger 1997; Berthoz and Petit 2008.) Such shared and recurrent meanings are based on two kinds of recognized patterns in the sensory flux: extensional *anschaulich* (intuitively meaningful) space-time patterns, and intensional[4] (conceptually meaningful) patterns of locally contextualized symmetry groups such as sensible qualia as well as personal or local community values or needs. The former is the symmetry (invariant) that characterizes abstract mathematical intuitions that are universally valid in principle for all mathematically oriented communities; the latter is the symmetry (invariant) that characterizes perception and measurement, both of which are contextualized by local empirical circumstances, communities, needs, and goals.

Classical physics is the natural science that assumes that the perceptual world is simply the instantiation of culture-free a priori mathematical objects. Underlying this assumption are a number of paradoxes. For example, although it is assumed that a finite number of elementary particles can make up a material thing of finite size, no finite number of points can make a line, surface, or volume, no matter how small. Clearly, then, at some point elementary particles will have to be treated differently from geometric points in space and time. Quantum physics has good theoretical and experimental reasons for giving up faith in the identity of physics with mathematics (Heelan 1965; 1974; 1975; 1979; 1987; 1988). Likewise from the mathematical side, although such numbers as 1, 2, and 3 have evident empirical counterparts, many others, such as the square root of -1, zero, infinity, and many other elements of the mathematical lexicon do not. Numbers in modern mathematics are human constructs and serve as elements of a quasi-grammar for the sciences.

This should not have been a surprising discovery in the context of human evolution because there is little likelihood that human visual and tactile perception would have been shaped by any practices other than those that coordinate the local actions of eyes, ears, hands, and legs that privilege a range of what turns out to be non-Euclidean finite visual spaces (Heelan [1983] 1988, Appendix). Cosmological matters of human interest, such as seasonal and weather changes, were treated by reading the signs in the heavens and in other ways, while matters of health and nourishment were managed by taste and smell and by reading nature's "signatures" in plants and animals. There is no a priori reason from evolution to justify the assumption of universal scientific trust in the *Anschaulichkeit* criterion of the modern scientific human imagination. Such trust was inherited mostly from the early modern period of European cultural history when it came to be incautiously accepted as fundamental for the mathematization of the physical world—small, medium, and large. In recent times it has gradually become evident that the very small and the very large need their own imaginative mathematical resource, linked to a common overarching structure of a transcendental kind. Important contributions to this end were made by Wigner (1962; 1963; 1967), John Wheeler and Wojciech Zurek (1983), Paul Dirac (1926), John von Neumann (1955), and others of their time who addressed the topic of microentities and their place side by side with macroentities in a common human world. They introduced the so-called orthodox form of the quantum theory—a Hilbert (infinite-dimensional vector) representation Space in which both classical and quantum entities could be represented, the classical by universal symmetries and the quantum by local contextual symmetries (Heelan 1974; 1979; Bracken 2003).

Hilbert Vector Space as the Grammar of a Science. Operators on Hilbert Space vectors represent practical measurement procedures that link the human subject instrumentally and perceptually with the micro- and macroentities represented in Hilbert Space by the vectors (Wheeler and Zurek 1983; Heelan 2004). The "grammar" of Hilbert Space can represent both the universal "absolute" symmetries of the world, namely free classical entities, and the "local contextual symmetries" of the world, namely the elementary building blocks of the world. In addition, quantum physics has discovered a strange new property of *spin* that reaches across all Space and Time to function as a global link among elementary particles in cosmic nature. This global linkage exemplifies one of the kinds of global "entanglement" (Aczel 2001; Shimony 1997; Gernert 2005). Such properties, while they stretch the powers of scientific thinking and observation beyond their natural human limits, serve to supply the intelligible foundation for the difference between the stable objects of the human world we live in and the instability of its dynamic foundations. Classical Space and Time can be seen in this perspective as the invariant of a stable historically changing human environment rather than an invariant of the preexisting unstable foundational world the existence of which humans have come only lately to recognize. Other spaces, such as the variety of visual spaces and historical times, belong to local contextual spaces and times. Quantum entities, however, would belong contextually to the unstable dynamic foundation of all human worlds.

How then are we to understand and represent to ourselves the "quantum microrealities" that appear fleetingly in laboratory experiments or the anomalous "cosmological macrorealities" that appear in astronomical studies of the cosmos? Each makes its presence known in classical Space and Time, but neither can be defined in its terms. Quantum microsystems and cosmological macrosystems both fail with respect to the kind of locality and causality that characterizes the imaginative intuition of the culture of early modern science as expressed in classical mathematics. Should we conclude that the criterion of *Anschaulichkeit* is the ontological criterion of a human culture and not the basis of universal natural laws?

The Uncertainty of Meaning Making: "Thin" versus "Thick" Descriptions (Geertz 1973, chap. 1; Williams 1985, 129–52). "Thin" description: Laboratory science and abstractive academic disciplines give thin descriptions. They are narrowly contextualized and theoretically (abstractly) defined. The life of a modern scientific community is permeated with thin descriptions, shielded as it is from having to take account of the diversity of surrounding cultures, horizons, agenda, styles, and goals.

"Thick" description: These are practical "world-guided" descriptions of actions or events that take account of local, historical, multicontextual, and multicultural niches. Thick descriptions permeate practical common life. Cultural knowledge is thick because it involves intercontextual discourse between speakers and hearers whose skill in such discourse is not narrowly disciplinary but culturally dialogical. Aristotle included it under character of prudence, "*phronesis*." This kind of discourse requires respect for the complexity and diversity of issues and authorities that characterize cultural human activity. Here the structure of the communicative exchanges is more like that of quantum theory—based, that is, on the choice of some relevant localized contextualized symmetry shared by all parties to the discourse.

DIALOGICAL SYNTHESES AND THE GRAMMAR OF HILBERT SPACE

Turning to the history of science, I would point to Ludwik Fleck (1979) as exemplifying a thick dialogical discourse. He narrates how the nature of syphilis as a disease gradually revealed itself to him as he redefined—gave a new spin to—a selection of old facts from diverse dialogical sources, from "old wives' tales" to odd pieces of popular medical lore to the outcomes of his experimental work. He found in his community's public memory many of the ingredients from which he got the insights that led him to define the two new scientific facts that have made him famous: the disease now known as syphilis and the spirochete that causes it.

Religion is also a domain of thick rational discourse. The meaning making of religious life and belief adds practical, social, and transcendental needs to the dimension of cognition. Such needs were shaped originally by biological evolution and expanded within human communities, where they were renewed and redefined by a succession of historically changing cultures. These skills are dialogical skills; they relate culturally to those whose authority we accept to regulate a community's conceptual norms, cultural goals, and practical affairs. An example of this kind of discourse is the work of Roman Catholic theologian Raymund Schwager (1999), who describes the message of Jesus as one of a transformative dialogical synthesis of stories from the Hebrew Bible and from the synoptic gospels of Mark, Matthew, and Luke.

Rational Dialogical Synthesis: Classical and Quantum Science. The initial conflict between classical and quantum physics is a version of the pre-Socratic question, Does nature hide behind classical physics? or behind quantum physics? If so, can they be the same nature? The key terms in the dispute often seem to be *objectivity* and *subjectivity*, but in fact the key notions relevant to the transition from classical to quantum physics are *intuition* (or *Anschaulichkeit*) and *measurement*—intuition in the mathematics of quantum physics, and measurement in data acquisition and management. These terms, deeply involved with Niels Bohr's notion of complementarity (see Beller 1999), are today clamoring for reexamination. A resolution of the dialogical conflict was proposed by Wigner and Dirac: The grammar and lexicon of both kinds of physics could be represented by a Hilbert Vector Space. In such a Space, a quantum system in pure (nonempirical) motion is represented as developing under the influence of the appropriate Schrödinger equation; empirical data, however, are represented mathematically by the eigen (proper definite) values of the data operators acting on the state vector and empirically by the actual data outcomes of the embodied subject's engagement in laboratory measurement.

The dialogical conflict was about the ontological and epistemological criteria of truth and reality in physics and focused on the question of how mathematical intuition can be reconciled with empirical observations so as to form a coherent human understanding of the natural world. Mathematical intuition is the a priori space of theoretical physicists; it structures, as it were grammatically, the a priori of the quantum narrative. Measurement defines the a posteriori empirical space of experimental physicists; it provides the data events to complete the narrative of facts. By introducing *complementarity*, Bohr and Heisenberg "fudged" the answer by attributing classical reality to the pure objects of mathematical theory while claiming that measurement has only limited empirical access to these classical realities. In Kantian (and Neo-kantian) terms, mathematics describes the *noumenon*, while complementarity restricts the sensory/perceptual *phenomenon.* Deeply involved in all of this is that mathematics was assumed to function as a pure—or, better, purified—discourse about the world of experience. In classical physics, its traditional function was to provide the intuition, *Anschaulichkeit*, of a generalized universal pure Space and Time that comprehensively "represented" the material world. This intuition was the sole reality guarantee of the "representation" provided by physical theory. Such a view of mathematics goes back to Plato's "likely story" in the *Timaeus*.

Two thousand years and more later, we can tell a more likely story! Our problem today is that quantum physics together with Einstein's relativity theory break the hard connection between the mathematical intuition of a universal *anschaulich* Space and Time and the commonsense dialogical criterion of physical truth and reality. Wigner, Dirac, and von Neumann were the first to make the breakthrough. Wigner (Szanton 1992, 309) was the key figure in this proclamation, being both the brother-in-law of Dirac and a schoolboy chum of von Neumann. He also was trained as a physical chemist and crystallographer and therefore familiar with the chemical laboratory. His mentor was Michael Polanyi (see Scott and Moleski 2005), also a physical chemist and later a well-known philosopher of science. Wigner applied to quantum theory the kind of group-theoretic mathematics—or grammar—that crystallographers use to categorize the symmetries of crystalline forms. These forms divide into two classes: universal (Space) symmetries, such as the invariants of the Galilean or Lorentz transformation group that are applicable to all physical objects, and the local symmetries of individual crystals that can belong to different local contextualized symmetries of shape—cubic, hexagonal, and so forth. Also in the formation of crystals local impurities play a fundamental role that foreshadowed the uncertainties of quantum physics.

Looking through the lens of group-theoretic symmetries, then, classical physics recognizes only the universal Space-Time groups of general physics. To this Wigner added projection operators that localized context-dependent groups of symmetries to subspaces of a Hilbert (infinite-dimensional) Vector Space that included both universal and local symmetries in one mathematical structure. For this insight Wigner was awarded the Nobel prize in physics in 1963.

The properties of physical objects in the "orthodox" view of quantum physics are now expressed as a combination of locally context-dependent symmetry groups and the universal Space-Time symmetry group. Classical physics is situated within it; it is the physics that ignores local context-dependent symmetries. However, Hilbert Space physics revolutionizes the science of physics because, by allowing for different local and mutually incompatible contexts or horizons of research, the physicist can unify her search by drawing on the broader heuristic question as to whether the unknown *X* (that one is studying) defines a universal symmetry of the Hilbert Space or a local context-dependent symmetry—and subspace—of the Hilbert Space. If I am researching a local symmetry, to set up a measurement I must design the laboratory so that what I observe is the local symmetry. The real-world model now unifies both in a common synthesis and in addition includes in its synthesis the presence of the local embodied observer whose real choice and activity enter into the group-theoretic definition of the local symmetries. Quantum physics has to recognize the dependence of observations on the context-dependent platform of the chosen laboratory. Although observations on the observed system simply add up coherently in classical physics, observations on the observed system from different local platforms do not simply add up to a coherent objective account. It is no longer possible in principle to give a comprehensive empirical description of a unified and objective "world" for all observers. There is no more than a unified and comprehensive grammar of the pure world-for-any-observer—the Hilbert Space with its systems of vectors and operators; but for any individual observer the world has context-dependent branches that are peculiar to that observer.

Because nature at the quantum level is only locally and contextually accessible to laboratory-embodied human practices, all such knowledge is partial, relative, and culturally perspectival. Is this, you ask, the little we get for the price we pay for scientific knowledge? No! We should not forget that the little we know of the quantum world is accompanied by the bonus of knowing something about ourselves—namely, what we do to the world as well as the interiority that human consciousness exemplifies. This reflection should keep us from continuing to assume that we study nature objectively from beyond the horizon of nature. Although we rule nature from within nature, we do not rule as monarchs of nature; we are more like its gardeners.

Rational Dialogical Synthesis: Schwager and God's Covenant. We turn now to the biblical theology of Schwager (1999), who is a Jesuit and a University Professor of Biblical Theology at the University of Innsbruck. Schwager has written a drama in five acts in which he proclaims the synthesis that Jesus proclaimed in the synoptic gospels between the Hebrew Bible and the "kingdom of God" that he preached. Schwager crafts an intelligible synthesis using the literary genre of drama. A drama is a story that starts out with conflict between two reasonable parties—in this drama, human and divine—and ends with peace and reconciliation shaped by a mutually acceptable re-definition of the mutual relationship between the parties in conflict. The story he tells is the synoptic gospels' story that the mission of Jesus was to bring about reconciliation between all people of faith, Jews and gentiles.

The drama that Schwager unfolds concerns a redefinition in the meaning of two terms, *God's goodness* and *God's justice*, terms found in both the Hebrew Bible and the synoptic gospels. In the gospels, Jesus, called God's Son, speaks on his Father's authority and gives these terms new meanings. Out of God's goodness, henceforth, all are offered unconditional forgiveness of offenses against God. This affects God's justice, because no price has been paid for the divine forgiveness. Jesus states that the price to be paid is his own death—that he, as God's own Son, will accept death to pay the price of sin, and his Father will accept that payment in satisfaction; it will satisfy not just for the sins of Israel but for the sins of all humankind. Schwager goes on to say that the Father further states that whoever accepts forgiveness through faith will be judged not by divine justice but differently—it will be measured by the justice they offer to others. Those who have not accepted forgiveness in faith will be subject as before to divine retribution.

Whatever one's faith, the reconciliation offered by this theological drama makes sense by the same rules that make sense of the transition from classical physics to quantum physics. Each case turns on the hermeneutical transformation of two subject-related terms: God's goodness and God's justice in the religious drama, intuition and measurement in the physics drama. The outcome of the religious drama was the merger of the Hebrew covenant with the new Christian covenant; the outcome of the physics drama was the merger of classical physics with the new quantum physics.

Intuition and measurement in classical physics take their meaning from the universal symmetries of four independent parameters: space, time, motion, and energy. They are transformed by bringing into play the opposition between intuition and measurement characteristic of quantum physics and based on the local contextual symmetries of just two independent pairs, space-time and motion-energy. Just as in Schwager's Jesus story the symmetry breaker for Christianity is accepting God's forgiveness, so the authors of the Hilbert Space story of physics would claim that the symmetry breaker for physics is the quantization of momentum and energy. Being hermeneutical and about meaning changes, the story of the synthesis of classical and quantum physics is a story that can be told only in the genre of dialogue or drama. One is reminded of Fleck's story of his discovery of the disease syphilis and the spirochete that is its cause.

Is a Theory of Human Consciousness Possible?

The human consciousness that is the Governor of Mental Life is the agent that produces and recognizes the categories for a strict theoretical science. Can human consciousness produce the categories to define itself?

Human consciousness produces categories and recognizes instances by becoming aware of recursive patterns of form and function in the sensory flux. If the only source of categorial knowledge is the embodied sensory flux, the question becomes: Has human consciousness access to the kind of embodied sensory flux that reveals the category to which human consciousness belongs? A category is a symmetry among a core set of embodied exemplars that is normative for all instances of its kind; a categorial symmetry is theoretical to the extent that elements of the set can substitute for one another as exemplars of the symmetry. Human consciousness is peculiar in that although we have no trouble recognizing exemplars of human consciousness—they are persons—we are hesitant to say that persons, *as persons*, can substitute for one another. They can substitute for one another in specific ways—as car buyers, as music lovers, as sports fans—but not as human consciousnesses, because this would imply that people can share the same personal identity.

Consequently, I claim that there is no theoretical category of human consciousness and therefore no theoretical science of human consciousness. The reason is that personal identity is expressed existentially, in the individual's living interiority or being-in-the-world. To understand that someone is a person is to recognize a likeness to oneself. It is not that we think the same thoughts, vote the same way, believe the same doctrines, and so on, but that he makes meanings the same way and makes choices the same way. If others are like me, they will be different knowers and doers and also like me imperfect, and like me governing themselves by their own choices and not by mine. Isn't this what it means to understand oneself as a person, as an exemplar of human consciousness? But this is not a categorial understanding of human consciousness, because few if any deductive inferences can be drawn from the descriptions of individual persons. The study of human consciousness led us to a theoretical study of the dynamic normative structures of intentionality, meaning making, and decision making but not to the existential choices and practical outcomes that individually shape the human consciousness that is a Governor of Mental Life.

To recapitulate, human knowers have the native ability to find patterns in the sensory flux and to share these patterns with members of the relevant language community. Such shared and reproducible patterns are of two kinds: patterns of universal symmetry groups, and patterns of locally contextualized symmetry groups. There are, then, two kinds of concepts: those based on universal symmetries and those based on locally contextualized existential symmetries. The former concern what can be universally understood about nature and are characteristic of classical physics; they represent what used to be called natural philosophy. The latter are about perceiving, theorizing, building laboratories, and measuring; these are hermeneutic sciences of existential exemplars and are characteristic of quantum physics. I claim in this essay that a general Hilbert Space, exemplified by quantum physics, represents an existential organization of knowledge that is capable of synthesizing both kinds of concepts. Quantum theory is a hermeneutic theory of the phenomena of human consciousness: a theory of how the Governor of Mental Life acts, providing a top-down norm that extends the notion of human rationality beyond the classical norms of Greek rationality to include the hermeneutic norms that make sense to human communities.

NOTES

A version of this essay was delivered at the conference "Physics, Philosophy, Physiology: Three Paths, One Spirited Product" at the University of Chicago Divinity School, 26 January 2007.

1. For further relevant glosses, see "Quantum Reality and the Consciousness of the Universe" 2006 for *Zygon* articles by Lothar Schäfer, Henry Stapp, and others related to this essay; see also Penrose 1994.
2. For an understanding of the philosophical conflicts within Roman Catholic theological thinking I thank Pope John Paul II's 1998 encyclical *Faith and Reason* (*www.vatican.va/edocs/ENG0216/_INDEX.HTM*) for its implicit endorsement of phenomenology as complementary to Greek philosophy. It is a proclamation that, however, does not resolve the problem of their synthesis (Heelan 2002). In the field of mathematics and theoretical physics I have learned from many complementary authorities: from Erwin Schrödinger and John Synge in lectures on classical non-Euclidean geometries; from personal communications with and writings of Wigner (1963; 1967) and Heisenberg (1971) on the role of subjectivity in assessing the rationality of the quantum theory; from discussions with Pribram and his writings (1971; 1991) on the building of a scientific model of human embodied consciousness; and from similar discussions with Farre and his writings (1998) on the building of a mathematical model of the evolutionary Cosmos. These, among many others too numerous to mention, are the principal sources of the rational heuristic I have used to explore the nature of the human consciousness and the Spirit that raises it up above pure Nature.
3. For the hermeneutic foundations of mathematics, see Lakoff and Nuñez 2000.
4. The terms *extension* and *intension* belong to mathematics and classical logic: extension connotes quantitative meanings (numbered or spatiotemporal), intension connotes cognitional (conceptual, logical) meanings. However, there is another term, *intention*, differing in spelling by only one letter—the letter *t*—with which it is regularly confused. Intention with a *t* connotes purpose or intent and is related to action and experience. A derivative term, *intentionality*, is central to a kind of philosophy that deals with how the meanings we make involve human action and experience. This is the philosophical phenomenology associated with Husserl, Merleau-Ponty, and Heidegger.

REFERENCES

Aczel, Amir. 2001. *EN tanglement: The Greatest Mystery of Physics.* New York: Four Walls Eight Windows.

Arnheim, Rudolf. 1974. *Art and Visual Perception.* Berkeley: Univ. of California Press.

Beller, Mara. 1999. *Quantum Dialogue: The Story of a Revolution.* Chicago: Univ. of Chicago Press.

Berthoz, Alain, and Jean-Luc Petit. 2008. *The Physiology and Phenomenology of Action.* New York: Oxford Univ. Press.
Bracken, Anthony J. 2003. "Quantum mechanics as an approximation to classical mechanics in Hilbert space." *Journal of Physics A: Mathematical and Theoretical* 36:23 (13 June), L329–L335.
Cassirer, Ernst. 1944. "The Concept of Group and the Theory of Perception." *Philosophy and Phenomenological Research* V:1–35.
Dirac, Paul. 1926. "On the theory of quantum mechanics." *Proceedings of the Royal Society of London (A)* 112:661–77.
Documents of Vatican II. 1966. Ed. Walter Abbott. New York: America Press.
Donald, Merlin. 2001. *A Mind So Rare: The Evolution of Human Consciousness*. New York: Norton.
Einstein, Albert. 1950. *Out of My Later Years.* New York: Philosophical Library.
Farre, George. 1998. "Characteristics and Implications for the Philosophy of Nature." *Acta Polytechnica Scandinavica* 91:3–12.
Fleck, Ludwik. 1979. *Genesis and Development of a Scientific Fact*. Trans. T. Trann. Chicago: Univ. of Chicago Press.
Geertz, Clifford. 1973. *The Interpretation of Cultures*. New York: Basic Books.
Gernert, Dieter. 2005. "Conditions of Entanglement." *Frontier Perspectives* 14:8–13.
Gibson, James J. 1979. *The Ecological Approach to Visual Perception.* Boston: Houghton Mifflin.
Hadot, Pierre. 2006. *The Veil of Isis*. Cambridge: Harvard Univ. Press.
Heelan, Patrick. 1965. *Quantum Mechanics and Objectivity: A Study of the Physical Philosophy of Werner Heisenberg.* The Hague: Nijhoff.
———. 1972. "Towards a New Analysis of the Pictorial Space of Vincent van Gogh." *Art Bulletin* 54:478–92.
———. 1974. "Quantum Logic and Classical Logic: Their Respective Roles." In *Logical and Epistemological Studies in Contemporary Physics*, ed. Robert S. Cohen and Marx Wartofsky, 318–49. *Boston Studies in the Philosophy of Science Series* 13. The Hague: Reidel.
———. 1975. "Heisenberg and Radical Theoretic Change." *Zeitschrift für allgemeine Wissenschaftstheorie* 6:113–38.
———. 1979. "Complementarity, Context-Dependence and Quantum Logic." In *The Logico-Algebraic Approach to Quantum Mechanics*, ed. C. Hooker, 161–79. Univ. of Western Ontario Series on the Philosophy of Science. Dordrecht, Netherlands: Reidel.
———. 1983. "Perception as a Hermeneutical Act." *Review of Metaphysics* 37:61–75.
———. [1983] 1988. *Space-Perception and the Philosophy of Science.* Berkeley: Univ. of California Press.
———. 1987. "Husserl's Later Philosophy of Natural Science." *Philosophy of Science* 54:368–90.
———. 1988. "Husserl, Hilbert and the Critique of Galilean Science." In *Edmund Husserl and the Phenomenological Tradition*, ed. Robert Sokolowski, 157–73. Washington, D.C.: Catholic Univ. of America Press.
———. 1994. "Galileo, Luther, and the Hermeneutics of Natural Science." In *The Question of Hermeneutics: Festschrift for Joseph Kockelmans*, ed. Timothy Stapleton, 363–75. Dordrecht, Netherlands: Kluwer.
———. 1998. "Scope of Hermeneutics in the Philosophy of Natural Science." *Studies in the History and Philosophy of Science* 29:273–98.
———. 2002. "Faith and Reason in Philosophical Perspective." In *La Responsibilité de la Raison: Hommage à Jean Ladrière*, ed. J.-F. Malherbe, 149–75. Leuven: Peeters.
———. 2003. "Phenomenology and the Philosophy of the Natural Sciences." In *Phenomenology World-Wide*, ed. A. T. Tymieniecka, 631–40. Dordrecht, Netherlands: Kluwer.
———. 2004. "The Phenomenological Role of Consciousness in Measurement." *Mind and Matter* 2:61–84.
———. 2006. Embodied Consciousness, *Anschaulichkeit,* and the Quantum Mind. Unpublished manuscript.
Heidegger, Martin. [1927] 1962. *Being and Time*. Trans. J. Macquarrie and E. Robinson. London: SCM Press.
———. [1950] 2002. *Off the Beaten Track*. Trans. J. Young and K. Haynes. Cambridge: Cambridge Univ. Press. (Original title: *Holzwege*.)

———. [1954] 1967. *What Is a Thing?* Trans. W. B. Barton Jr. and V. Deutsch. Chicago: Regnery. (Original title: *Die Frage nach dem Ding*.)

———. 1982. *On the Way to Language*. Trans. P. D. Hertz. New York: Harper and Row.

———. [1989] 1999. *Contributions to Philosophy (From Enowning)*. Trans. Parvis Emad and Kenneth Maly. Bloomington: Indiana Univ. Press.

———. 1995. *Ontology (Hermeneutics of Facticity)*. Trans. J. van Buren. Bloomington: Indiana Univ. Press.

———. 2002. *Supplement: From the Earliest Essays to Being and Time and Beyond*. Ed. J. van Buren. Albany: State Univ. of New York Press.

Heisenberg, Werner. 1971. *Physics and Beyond: Encounters and Conversations.* New York: Harper and Row.

Husserl, Edmund. [1901–1913] 1970. *Logical Investigations*. Ed. and trans. J. N. Findley. New York: Humanities Press.

———. [1952] 1989. *Ideas II*. Eng. trans. R. Rojcewicz and A. Schuwer. Dordrecht, Netherlands: Kluwer.

———. [1954] 1970. *The Crisis of European Sciences and Transcendental Philosophy: An Introduction to Phenomenological Philosophy*. Trans. D. Carr. Evanston, Ill.: Northwestern Univ. Press.

———. 1966. *Analyses concerning Passive and Active Synthesis* (*Analysen zur passiven Synthesis*). Eng. Trans. A. Steinbock. Dordrecht, Netherlands: Kluwer.

Jacob, Francois. 1988. *The Statue Within: An Autobiography*. Trans. Franklin Philip. New York: Basic Books.

Jacob, Pierre, and Marc Jeannerod. 2003. *Ways of Seeing: The Scope and Limits of Visual Cognition.* Oxford: Oxford Univ. Press.

Lakoff, George, and Rafael Nuñez. 2000. *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being.* New York: Basic Books.

Lonergan, Bernard. [1957] 1992. *Insight: A Study of Human Understanding*. Toronto: Univ. of Toronto Press.

———. [1972] 1990. *Method in Theology.* Toronto: Univ. of Toronto Press.

Luneburg, Rudolf. 1947. *Mathematical Analysis of Binocular Vision*. Princeton, N.J.: Princeton Univ. Press.

———. 1950. "The metric of visual space." *Journal of the Optical Society of Am*erica 40:627–42.

Merleau-Ponty, Maurice. 1962. *The Phenomenology of Perception.* New York: Routledge and Kegan Paul.

Penrose, Roger. 1994. *Shadows of the Mind: A Search for the Missing Science of Consciousness.* Oxford: Oxford Univ. Press.

Pribram, Karl. 1971. *Languages of the Brain: Experimental Paradoxes and Principles in Neuropsychology.* Englewood Cliffs, N.J.: Prentice-Hall.

———. 1991. *Brain and Perception: Holonomy and Structure in Figural Processing.* Hillsdale, N.J.: Erlbaum.

"Quantum Reality and the Consciousness of the Universe." 2006. Section of articles in *Zygon: Journal of Religion and Science* 41:505–98.

Rheinberger, H.-J. 1997. *Toward a History of Epistemic Things.* Stanford, Calif.: Stanford Univ. Press.

Ryckman, Thomas. 2005. *The Reign of Relativity: Philosophy in Physics 1915–1925*. Oxford: Oxford Univ. Press.

Schwager, Raymund. 1999. *Jesus in the Drama of Salvation: Toward a Biblical Doctrine of Redemption*. New York: Crossroad.

Scott, William T., and Martin X. Moleski. 2005. *Michael Polanyi: Scientist and Philosopher.* Oxford: Oxford Univ. Press.

Shimony, Abner. 1997. "On mentality, quantum mechanics and the actualization of potentialities." In Roger Penrose (with A. Shimony, N. Cartwright, and S. Hawking), *The Large, the Small and the Human Mind*, 144–60. Cambridge: Cambridge Univ. Press.

Szanton, Andrew. 1992. *Recollections of Eugene Wigner.* New York: Plenum.

Tomasello, Michael. 1999. *The Cultural Origins of Human Cognition.* Cambridge: Harvard Univ. Press.

von Neumann, John. 1955. *Mathematical Foundations of Quantum Mechanics*. Ed. R. T. Beyer. Chap. VI, 417–45. Princeton, N.J.: Princeton Univ. Press.
Wellmon, Chad. 2006. "Poesie as Anthropology: Schleiermacher, Colonial History, and the Ethic of Ethnography." *The German Quarterly* 79:423–42.
Welton, Donn. 2000. *The Other Husserl: The Horizons of Transcendental Phenomenology.* Bloomington: Indiana Univ. Press.
Wheeler, John A., and Wojciech H. Zurek. 1983. *Quantum Theory and Measurement*. Princeton, N.J.: Princeton Univ. Press.
Wigner, Eugene. 1962. "Remarks on the Mind-Body Question." In *The Scientist Speculates*, ed. I. J. Good, 284–301. London: Heinemann.
———. 1963. "The Problem of Measurement." *American Journal of Physics* 31:6.
———. 1967. *Symmetries and Reflections: Scientific Essays of Eugene P. Wigner.* Bloomington: Indiana Univ. Press.
Williams, Bernard. 1985. *Ethics and the Limits of Philosophy.* Cambridge: Harvard Univ. Press.