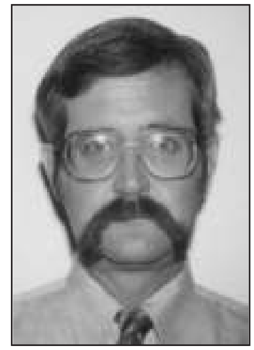
Mathematics and Metaphysics

Ben M. Carter

In this paper, I argue that metaphysics, logic, and mathematics, as systematic investigations into the nature of order and knowledge, have much in common, and that mathematics as the way science quantifies data can be the vehicle science uses to investigate ultimate questions. Then referring to the work of George Lakoff and Rafael Núñez, I ask whether mathematics expresses something innate in the universe or something innate to the structure of the human brain. In raising this question, I argue that if the universe itself is mathematical, then dualism is affirmed and materialism falsified. However, if mathematics only expresses the cognitive structure of the human brain, as Lakoff and Núñez maintain, then it is compromised as a reliable guide for understanding the ultimate nature of the cosmos. In the later case, it follows that science will be unable to address metaphysical questions in any compelling way.



Physicist Brad Keister has observed that while the Reformers made significant contributions to the development of the scientific method, secularists have appropriated that method as their own in their struggle against a religious world view. Therefore, he argues, it is incumbent upon secularists to construct a world view which is not only consistent but "allows for a system of inquiry based on rational thought."[1]

Secularism, because it rejects transcendent reality in favor of an immanent one, adopts de facto a materialistic world view. In this paper I wish to examine one of the significant problems a thoroughgoing materialist would confront in constructing a world view that is both consistent and allows for rational inquiry. The problem is this: as a philosophical theory, materialism regards all phenomena in the universe, including those of mind, to be composed solely of matter in motion.[2] However, to quantify its observations and generalize about such matter in motion, science employs reason and more specifically mathematics. To compel assent, reason and mathematics must be universal, but the universality of both is precisely what materialism undermines.

The Question of Order

Metaphysics, logic, and mathematics are all investigations into the nature of order and the principles of knowledge.

Metaphysics involves the exploration of the ultimate tenets of knowledge, the ultimate causes of existence and change, and the principles of order that determine the interrelations of the universe.

Logic is the science that investigates the principles of correct (deductive) or reasonable (inductive) inference.

Mathematics is the systematic investigation of magnitude, the relationships between figures and forms, and the relationships between quantities expressed symbolically.

A mathematical formula displays in symbolic form a relationship whereby the value of one variable can be found from one or several other variables. Many mathematical theorems are exhibited as formulas, and many scientific conclusions are embodied in mathematical formulas as well. Thus the use of mathematics in science supposes that at some basic level, the material cosmos operates according to mathematical principles.

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matical, has a strong metaphysical component. Both mathematics and logic are problem-solving systems and may be used to unravel issues that appear in either physics or metaphysics.

In metaphysics, mathematics, and logic, the axioms must be true within the system employed, that is, at a minimum, they must be noncontradictory, otherwise the conclusions based on those axioms will not be compelling. Ideally, once the premises are granted or established, the argument that follows must be necessarily true providing no errors are made as one unfolds the argument. Hence the truths of metaphysics, mathematics, and logic are system-dependent truths. However, there is this important difference: while metaphysics purports to be about the universe, mathematics and logic do not. Both are constructs of pure abstraction. Mathematics, like pure reason, gives no set of data preference. When doing pure mathematics, a mathematician does not profess to say anything about physical reality. Mathematics is instead an exploration of relationships between concepts. Thus mathematics and pure reason are not dependent on the universe in whatever form it might take.[3]

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The universe is a contingent reality. It unfolds in an orderly way (thus meaningful generalizations can be made about it), but the particular forms it assumes cannot be fully grasped apart from their history. The universe is as it is, but within certain limits it might have been different. We have discovered that the universe is far more complex than we initially supposed, but we also have discovered that the principles underlying that complexity seem to be fairly simple. Modern empirical science, to study the complexities of the universe, attempts to reduce them to modules that it can investigate piecemeal in an effort to determine the simple principles underlying the selected phenomenon. In this investigation, mathematics has become increasingly important.

Mathematical models do not provide complete descriptions of natural phenomena. Rather they are attempts to establish the boundary conditions of phenomena.[4] In doing this, mathematics forces us to make our assumptions explicit and allows us via calculations to extrapolate those assumptions beyond our immediate perceptions.[5] Thus mathematics, because it allows us to explore relationships between conceptualized quantities even if they can be expressed only symbolically, enables us to model phenomena that exist beyond our everyday experience.[6] This process can seem very mechanical as the psychologist Thomas Gilovich points out. He observes that to protect a researcher from manipulating the meaning of data, the scientific method is designed to make the researcher "rigid and 'unintelligent,'" and he writes: "As scientists we willingly sacrifice some 'intelligence' and flexibility for the benefit of objectivity."[7] In this way, mathematics allows science to draw conclusions that, while they may be counter-intuitive, are quite reasonable given the data, the automatic nature of the calculations, and the assumptions made while establishing the data's boundary conditions. Hence, if the principles of mathematics are not necessarily true, then its use as an investigative tool is severely compromised.

There are two key points I wish to make here. First, like metaphysics, science is interested in the principles of order that determine the interrelationships of the universe, but insofar as science relies on empiricism, it is unable to plumb ultimate causes. As a conceptual tool, mathematics helps science move toward more ultimate explanations, that is, mathematics can enable science to address metaphysical concerns. We see this happening as scientific findings are applied to questions of origin (e.g., whence the universe, whence life, whence ethics) or the nature of existence itself.

Second, mathematics and logic, precisely because they deal in necessary truths, suggest that reality cannot be reduced to the physical since the physical exists contingently. John Barrow describes this in another way, as mathematics being bigger than physical reality,[8] since "mathematical existence allows anything to 'exist,'"[9] but what is logically possible need not exist physically.[10] Thus, attempts to use mathematics and logic to explain the physical mean that science, because it assumes a necessary/contingent dichotomy, implicitly models reality in a dualistic way. We see then that pure materialism cannot provide a rational account of the universe, and, insofar as it tries, it is self-refuting.

The Problem of the Particular

Within a pluralistic framework, being or existence is expressed in many particular and distinct ways, that is, things exist within limits and each limited thing's existence is not necessarily identical with any other limited thing's existence. Rather the essence of each thing, if a thing can properly be considered to have an essence, is defined by its limitations. Its essence is the limiting principle of both a limited thing's being and accidents. Our universe with its quasars, wasps, planets, tobacco smoke, and chocolate would seem to constitute a pluralistic framework. Given such a framework, an obvious question occurs to philosophers: how does one attain to certain knowledge of a thing within that environment?

To resolve that problem, Plato (427–347 BC) proposed that the universe was created as an immaterial formal realm interfaced with a material chaotic one. When Plato introduced the idea of Forms, he was not trying to address ontological concerns as much as epistemological ones. The question that concerned him was how he knew a thing is what it is. Plato also recognized that without the ability to generalize, knowledge would be reduced to a mere catalogue of particulars. The idea that a formal realm gave coherence to a disorderly chaos of particulars was his solution to the problem. His proposal meant not only that he could give an account of identity, it also meant that he could justify generalizations. In this elucidation of identity and generalization, Plato created a viable theory of knowledge.

In Chapter 26 of his *Republic*, Plato emphasizes the eternal character of mathematical objects and describes geometry as the study of the eternally existent. He includes both geometry and solid geometry among the five sciences that turn the soul's eye from the material world to objects of pure thought. Certain elements of geometry had been mastered by the Egyptians and Babylonians, and Pythagoras (c 582–c 500 BC) did much to advance the subject. Alfred North Whitehead in *Science and the Modern World* remarked that "the generality of mathematics is the most complete generality consistent with the community of occasions which constitutes our metaphysical situation."[11] As such mathematics describes general conditions that transcend any set of particular entities, and it is these absolutely general conditions that concern logic.[12] Whitehead went on to argue that abstract logic "is nothing else than the exhibition of the whole pattern of general conditions involved in the pattern derived from [one's] selected postulates."[13] And this, Whitehead argued, meant that the harmony exhibited by logical reasoning is established as a general aesthetic in the prevailing conditions that comprise any specific event.[14] Whitehead credited Pythagoras as the first person "who had any grasp of the full sweep of this general principle."[15]

Plato was one of those philosophers who built on the work of Pythagoras as did Plato's most famous student Aristotle. Around 300 BC, Euclid, a geometrician who lived in Alexandria, published his *Elements*, a systematic arrangement of the geometry of his day based on postulates that held true in ordinary three-dimensional space. Thus Plato's realm of Forms was given extensive rigorous definition and geometry's meta-physical dimensions were secured.

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The metaphysical side of reason and mathematics was made even more explicit when the neo-Platonists identified reason with the universal *logos*, and Christians incorporated that concept into the person of Christ. Mathematics and reason became a window into the mind of the Christian God. Galileo Galilei, voicing a perspective that spanned the mid-sixteenth to the mid-seventeenth century, is very categorical in his assessment here. Believing that, in certain areas, the human intellect was capable of a level of knowledge that was on a par with the divine, he wrote:

> I say that the human intellect understands some things so perfectly and it has such absolute certainty of them that it equals nature's own understanding of them; those things include the pure mathematical sciences, that is, geometry and arithmetic about which the divine intellect knows infinitely more propositions since it knows them all, but of those few understood by the human intellect I believe that its knowledge equals divine knowledge in its objective certainty.[16]

Mathematics, according to Galileo, symbolically expressed the conceptual framework of the universe and did so in a way that was necessarily true via a process that was necessarily reliable.

In urging science to abandon the idea of Formal reality, Francis Bacon undermined Plato's achievement and reintroduced the epistemological dilemma Plato had resolved. However, by measuring and quantifying, and by employing the automatic processes of mathematics and reason, science allowed for meaningful generalizations and in effect retained formal reality. In its systematic investigation of magnitude expressed in science's concern for accurate mensuration, mathematics resolved the problem of identity. In its systematic investigation of relationships, mathematics resolved the problem of generalization. In modern empirical science, mathematics in effect took the place of Plato's Forms.

This should not be surprising. As the historian of myth Giorgio de Santillana has pointed out, science has its origins in the myth of invariance,[17] an invariance willed by God and accessible through God's mathematics. "[W]e have," he claims, "been living in the age of Astronomical Myth until yesterday."[18] Indeed, many mathematicians from Pythagoras to Georg Cantor (1848–1918) believed the mathematical exploration of infinity had theological significance and saw in such research a way to harmonize mathematics and religion.[19]

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To reprise, mathematics as described above seems to imply a dualistic cosmos since it assumes the reality of mathematical integrity, an integrity that is undistorted by any configuration or expression of the material domain. The material, though structured by mathematics, cannot impact it. Mathematics must remain inviolable since its value as a means of attaining to the truth rests upon its inviolability. This classic vision of mathematics recapitulates the sacred and profane partitioning of reality with mathematics assuming the sacred role. Mathematics in such a scenario, while accessible to the human brain, is, as Galileo believed, firmly situated in the mind of God. But even if there is no God, mathematics must remain distinct from the world if it is to be useful because it provides an absolute standard against which mundane phenomena are quantified. If mathematics itself is simply another mundane phenomena, it loses its modeling value. Thus whether God does or does not exist, mathematics in this classical formulation implies dualism.

If, however, we assume that our perceptions are fundamentally conceptual in nature, as neurobiological research suggests they are, and if we assume that mathematics is fundamentally conceptual in nature, then might not the interfacing of these two orders of concepts create an illusion so powerful that we would not be able to escape from it and might not even be aware that it is an illusion save when it generates apparent contradictions in (what would seem to us to be) extreme circumstances? To put the question another way: what if mathematics itself were embodied in the structures of the human brain but not expressed in any fundamental way in the cosmos? What if mathematics, like other forms of human reasoning since Kant, might have only limited abstractive value? And if the materialist is right, what grounds would the materialist have for asserting that mathematics enjoys a privileged position in the acquisition of knowledge?

In *Where Mathematics Comes From,* George Lakoff and Rafael Núñez make such an argument. They seek to launch the discipline of mathematical idea analysis from a cognitive perspective.[20] They are concerned with how the cognitive superstructure of a nexus of mathematical ideas is constructed,[21] and ask where mathematical ideas come from and whether they can be analyzed from a cognitive perspective.[22] They aspire to tell the reader what human mathematics, conceptualized via the human brain and mind, is like.[23] The book is not concerned just with what is true, but also with the nature of mathematical truth: what mathematical ideas mean, how they can be understood, and why they are true.[24] As such, the authors seem to have embarked on an intellectual voyage not unlike Foucault's attempt to exhume the archeology of knowledge. They ask the central question: "What is the cognitive structure of sophisticated mathematical ideas?"[25] The book is not about conscious, goal-oriented mathematical cognition, but about mathematical cognition of an automatic, unconscious sort.[26] The authors seek to explore how the general cognitive mechanisms used in everyday nonmathematical thought can create mathematical understanding and structure mathematical ideas.[27] Because the human conceptual system is known to use metaphors, much of the book is concerned with metaphor.[28]

Lakoff and Núñez try to make the case that human mathematical reasoning works in the way that other human abstract reasoning works: via sensory-motor grounding and metaphorical projection.[29] The point is not the mathematical analysis of mathematical concepts but the cognitive or conceptual analysis of mathematical concepts.[30] They want to understand how mathematical ideas are conceptualized via metaphor and to give an account in terms of human cognition of the ideas the metaphors are meant to express.[31] They argue that their theory of "embodied mathematics" describes what mathematics really is.[32] Since they believe that mathematical ideas have a precise structure that can be discovered and explored, they have written *Where Mathematics Comes From* as a first step in that process of discovery and exploration.[33] Thus they are addressing mathematics from the perspective of conceptualist/structuralist philosophy.

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Lakoff and Núñez argue that mathematics is a human creation and that any mathematics we can know is limited and structured by the human brain and human mental capacities. Therefore all of our mathematics is human mathematics and as such must be brain- and mind-based mathematics.[34] Ideas can be created only by, and instantiated only in, brains [there is an assumed identity between mind and brain].[35] Mathematics does not exist objectively apart from the mind [brain].[36] It is not *mind-free*; instead mathematics are grounded upon a conceptual, mind-based substructure.[37] The human brain is not a general purpose device. Human concepts, including mathematical concepts, are highly structured and limited because of the structure of the brain itself, the human body, and the world in which we live.[38] The only access we have to any mathematics at all is through concepts in our minds that are shaped by our bodies and brains and realized physically in our neural systems. For any embodied beings, the only mathematics that can be known is embodied mathematics, that is, the mathematics that our bodies and brains allow us to know.[39]

According to Lakoff and Núñez, there is no difference between human mathematical concepts and mathematical concepts.[40] Human mathematics is not transcendent nor is it part of the physical universe. Rather it is a creation based on metaphors derived from our experience of external objects.[41] But though we create mathematics, mathematics is not arbitrary. Mathematics is based on the fundamental conceptual mechanisms of the embodied human mind as it has evolved in the world.[42] Every concept we have must somehow be characterized in the neural structure of our brains, and every bit of thinking we do must be carried out by neural mechanisms of exactly the right structure to carry out that form of thought.[43] For example, our mathematics of calculation, and the notation we do it in, is chosen for bodily reasons. The very idea of a linearly ordered symbolic notation of mathematics arises from the peculiar properties of our bodies.[44]

Lakoff and Núñez note that mathematics has changed enormously over time, that forms of mathematics often vary from community to community across the mathematical world, and that mathematicians often differ in their interpretations of mathematical results.[45] They argue that mathematical ideas can be impacted by culture (the Greek idea of essences is one key example they use)[46] or by technology (floating-point arithmetic used in computers is their key example here).[47] They argue that subject matters in mathematics tend to have multiple versions for historical reasons and that there is no way to predict what new forms of mathematics mathematicians will invent.[48] Because mathematicians live at specific times and base their work on the work of earlier mathematicians, mathematics evolves over time. Thus the progress of mathematics is nonlinear, and mathematical results can be inconsistent with one another.[49] Such inconsistencies express the different potentials in the different metaphors mathematicians employ.[50] Thus human mathematics is not monolithic. It embraces distinct versions of disciplines which, though internally consistent, can be mutually inconsistent.[51] In all of this, they see evidence of the contingent quality of mathematical concepts. In other words, mathematics is a schematic representation of how the brain/mind works, our mathematical models are projections of that schematic representation, and "there is no way to know whether theorems proved by human mathematicians have any objective truth."[52]

It would follow from this that, like logic, mathematics so conceptualized cannot really assist us in constructing any exhaustive model of reality. As Immanuel Kant and his contemporary disciples like psychologists Steven Pinker and Thomas Gilovich have pointed out, the human mind seems to be constructed so as to enable us to identify general principles that work well enough to empower us to survive and reproduce, but it does not seem particularly well adapted for tasks like detailed analysis. And indeed we do seem prone to all kinds of conceptual mistakes. Traditionally scientists have relied on mathematics to assist them in overcoming such mistakes, particularly in data analysis or in modeling conditions beyond our immediate experience. But if Lakoff and Núñez are correct, not only would mathematics be fundamentally unreliable for such a task, difficulties inherent in mathematical extrapolations would not be immediately obvious though they might become so as we began to explore possibilities (from our perspective) on the "edges" of things: while trying to make sense of data derived from the cosmic or the subatomic

levels, while addressing questions of divine foreknowledge, while speculating on time-travel scenarios, while puzzling over the existence of free will, and so on. We naturally ask such questions, but lack the capacity to arrive at any final resolution concerning them.

Conclusion

This then is the dilemma to which Brad Keister pointed and which the secularist must address: if all there is, is matter in motion, and if awareness is simply a peculiar expression of certain configurations of matter, what, beyond mere pragmatism, compels us to accept any purely materialistic resolution of ultimate questions? The materialist simply has no way to address such queries. The data the materialist employs are too artificial, the process of analysis too inherently limited, to compel one solution over another. Indeed, materialism is revealed not as a rational alternative to dualistic or theological models of the universe but as an oddly irrational one, an alternative that begins by limiting its options for no obvious reason,[53] and then, having limited them, insists that all solutions must be subsumed under a regime so truncated that it cannot even address our questions. This represents a leap of faith that might have intimidated Kierkegaard himself! On the other hand, if one rejects the Lakoff/Núñez model of mathematics, then one ultimately embraces a de facto dualism and falsifies materialism. Thus the materialist is tossed on the horns of a dilemma. If he is right, he cannot prove it. If he can prove it, he is wrong.

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In a *New York Times* article on black holes, Dr. Raffael Bousso of the University of California at Santa Barbara, describing the holographic principle first articulated in 1993 by Dr. Gerard 't Hooft of Utrecht and later developed by Dr. Leonard Susskind of Stanford University, said: "We clearly see the world the way we see a hologram. We see three dimensions. When you look at one of those chips, it looks pretty real, but in our case the illusion is perfect." Susskind added as clarification for the reporter, "We don't read the hologram. We are the hologram."[54] This means that it is a fundamental mistake to attempt to imagine the universe as it appears to God,[55] and that our models of the universe, even those models based on mathematics, are forever doomed to reflect the holographic perspective of the observer. The materialist, if he is right, is condemned to be trapped forever within a near perfect illusion, one he may know is there, but one he cannot in principle transcend.

Notes

[1] Brad Keister made this comment while addressing a conference organized by InterVarsity Graduate and Faculty Ministries and held between October 13–15, 2000, at the University of Saint Mary's of the Lake in Mundelein, Illinois. See "What Are the Research Needs in Science?" *Perspectives on Science and Christian Faith* 53, no. 4 (December 2001): 270.

[2] So far as I am aware, the best overall contemporary defense of this principle is Francis Crick's *The Astonishing Hypothesis* (Old Tappan, NJ: Simon & Schuster, 1994). In this book Crick argues that a person's mental activities can ultimately be reduced to the behavior of atoms, ions, and molecules as they are constituted in neurons and glial cells. The book is valuable as an insightful and critical discussion of the strengths and weaknesses of this thesis, and contains a wealth of experimental data which neuroscientists, the vast majority of whom, Crick assures us, are thoroughgoing materialists, interpret as justifying this position.

[3] Susanne K. Langer, *Philosophy in a New Key* (New York: A Mentor Book, The New American Library, 1951), 27–8.

[4] Robin Dunbar, *The Trouble with Science* (Cambridge, MA: Harvard University Press, 1995), 99.

[5] Ibid., 113.

[6] Ibid., 142.

[7] Thomas Gilovich, *How We Know What Isn't So* (Old Tappan, NJ: Simon & Schuster Inc., 1991), 58.

[8] John Barrow, *The Book of Nothing* (New York: Pantheon Books, 2001), 149, 164–5.

[9] Ibid., 286.

[10] Ibid., 284.

[11] Alfred North Whitehead, *Science and the Modern World* (New York: The Free Press, 1925), 25.

[12] Ibid.

[13] Ibid., 26.

[14] Ibid.

[15] Ibid., 27.

[16] Quoted in Michael Hardt and Antonio Negri, *Empire* (Cambridge, MA: Harvard University Press, 2000), 72–3. John D. Barrow also quotes this passage in *The Book of Nothing,* p. 86, taking it from Galileo, *Dialogue Concerning Two World Systems,* trans. S. Drake (Berkeley: California University Press, 1953), 103–4.

[17] Giorgio de Santillana, *Hamlet's Mill* (Boston: Gambit, Inc., 1969), v.

[18] Ibid., vi.

[19] George Lakoff and Rafael Núñez, *Where Mathematics Comes From* (New York: Basic Books, 2000), 162–3.

[20] Ibid., xi.

[21] Ibid., xiv.

[22] Ibid., 2.

[23] Ibid., 3.

[24]Ibid., 8, 338.
[25]Ibid., 15.
[26]Ibid., 28.
[27]Ibid., 29.
[28]Ibid., 100.
[29]Ibid., 101.
[30]Ibid., 170.
[31]Ibid., 273.
[32]Ibid., 346.
[33]Ibid., 375.
[34]Ibid., 1, 4.
[35]Ibid., 33.
[36]Ibid., 343.
[37]Ibid., 373, 376.
[38]Ibid., 1, 4.
[39]Ibid., 346.
[40]Ibid., 3.
[41]Ibid., 349, 364.
[42]Ibid., 9.
[43]Ibid., 347.
[44]Ibid., 86.
[45]Ibid., 349.
[46]Ibid., 107, 161, 357.
[47]Ibid., 360–1.
[48]Ibid., 355.
[49]Ibid., 359.
[50]Ibid., 265, 278, 333.
[51]Ibid., 352, 354.
[52]Ibid., 2.
[53]Perhaps at one time the materialist could plausibly claim that the tangibly physical was the obvious place to begin if we wanted to develop a valid model of reality, but that proposition, always questionable, has become even more so. Today cosmologists claim that about seventy percent of the universe is made up of dark energy and about twenty-five percent is made up of dark matter. That means matter as we know it comprises only about three to five percent of the density of the observable universe. Thus there is no longer any justification for giving our material state central position when we construct cosmic models, indeed there is every reason not to accord it such primacy.
[54]Dennis Overbye, "Hawking's Breakthrough Is Still an Enigma," *The New York Times*, January 22, 2002, sec. D, pp. 1, 4.
[55]Ibid., sec. D, p. 4.

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