

Locke on Newton's *Principia mathematica*: Mathematics but not Natural Philosophy?

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In his *Essay concerning Human Understanding*, John Locke explicitly refers to Newton's *Philosophiae naturalis principia mathematica* in laudatory but restrained terms: "Mr. *Newton*, in his never enough to be admired Book, has demonstrated several Propositions, which are so many new Truths, before unknown to the World, and are farther Advances in Mathematical Knowledge" (*An Essay Concerning Human Understanding*, ed. P. H. Nidditch [Clarendon Press, 1975], 4.7.3). Locke's restraint stands in contrast to such effusive tributes as Edmund Halley's *Ode* ("Come celebrate with me in song the name/ Of *Newton*, to the Muses dear; for he/ Unlocked the hidden treasuries of Truth:/ So richly through his mind had Phoebus cast/ The radiance of his own divinity./ Nearer the gods no mortal may approach") or the famous epitaph of Alexander Pope ("Nature and Nature's laws lay hid in night; / God said, Let *Newton* be! and all was light").

Of course, Locke was neither a poet nor inclined to make use of a poet's license. There can be little doubt, I think, that he respected Newton's prodigious intellect and admired his accomplishments. In the *Essay*'s "Epistle to the Reader" of 1700, "the incomparable Mr. *Newton*" is numbered along with Boyle, Sydenham, and Huygens as one of the commonwealth of learning's master-builders in advancing the sciences. Also more expansive is the 1688 review of Newton's *Principia* in Le Clerc's *Bibliothèque universelle et historique*, which many scholars now believe was written by Locke, and a passage from Locke's 1693 *Some Thoughts Concerning Education*. Locke was dead by the autumn of 1704. But a number of early eighteenth-century Newtonians were prepared to enlist him as a convert—albeit a non-mathematical one—to the cause

of Newtonian natural philosophy. Perhaps most famously, Desaguliers, in the preface to his *A Course of Experimental Philosophy* of 1734 names Locke as proto-Newtonian:

The great Mr. Locke was the first who became a Newtonian Philosopher without the Help of Geometry; for having asked Mr. Huygens, whether all the mathematical Propositions in Sir Isaac's Principia were true, and being told he might depend on their Certainty; he took them for granted, and carefully examined the Reasonings and Corollaries drawn from them, became Master of all the Physicks, and was fully convinc'd of the great Discoveries contain'd in that Book: Thus also he read the Opticks with Pleasure, acquainting himself with every thing in them that was not merely mathematical (J. -T. Desaguliers, *A Course of Experimental Philosophy*, vol. 1 [John Senex, 1734]).

Recent scholarship pertaining to the relation between Locke and Newton has surely produced a more nuanced and complex picture than that of Locke as a card-carrying Newtonian *sans* the maths. In particular, Lisa J. Downing's paper ("Locke's Newtonianism and Lockean Newtonianism," *Perspectives on Science*, 5: 3 [1997], 285-310) provides a fine treatment of its topic. In comparison, my purpose today is limited and, I hope, modest: I intend to add what I regard as a footnote to Downing's paper. I shall suggest that it is precisely Locke's epistemological idealism—that is, his adherence (in common with Descartes) to the Way of Ideas—that entails that he must regard Newton's accomplishments in the *Principia* as mathematical *rather than* as a grand edifice of natural science.

I obviously do not have time to undertake a full exposition of Locke's epistemology. Rather, I shall list some fundamental elements of that epistemology that are particularly relevant to my argument.

(1) The Way of Ideas. Ideas are the only immediate objects of conscious awareness. The term 'idea', Locke says, "serves best to stand for whatsoever is the Object of the Understanding,

when a man thinks” (*Essay*, 1. 1. 8).

(2) Epistemological atomism. Complex ideas are ultimately resolvable into simple components. “Though the Qualities that affect our Senses, are, in the things themselves, so united and blended, that there is no separation, no distance between them; yet ‘tis plain, the Ideas they produce in the Mind, enter by the Senses simple and unmixed” (*Essay* 1. 2. 1).

(3) The double-existence hypothesis. In the case of our ideas of sensation, a distinction must be made between the idea, to which we have epistemic access, and what Locke terms a quality—which is usually conceived by Locke as the cause of the idea but, at least in some cases (ideas of primary qualities), may be what we could call the external, intentional object or correlate of the idea. “To discover the nature of our *Ideas* the better, and to discourse of them intelligibly, it will be convenient to distinguish them, as they are *Ideas* or Perceptions in our Minds; and as they are modifications of matter in the Bodies that cause such perceptions in us. . . . Whatsoever the Mind perceives in it self, or is the immediate object of Perception, Thought or Understanding, that I call *Idea*; and Power to produce any *Idea* in our mind, I call *Quality* of the Subject wherein that power is” (*Essay* 2. 8. 7-8).

(4) The primary quality/secondary quality distinction and the corpuscularian hypothesis. Some ideas, those of primary qualities, resemble the qualities of material substances that are their causes. Other qualities, secondary qualities, do not resemble the qualities of material substances that are their causes. In the latter case, Locke follows Boyle and others in hypothesizing that our ideas of secondary qualities (e.g., color, sounds, smells, flavors) are caused by the primary qualities of the individually insensible corpuscles of matter constituting material substances. However, I agree with Downing that Locke’s adherence to corpuscularianism is hypothetical and

(relatively) non-dogmatic.

(5) Knowledge in the strict sense (*scientia*) as an intuitive-demonstrative relation between ideas. “*Knowledge* then seems to me to be nothing but *the perception of the connexion and agreement, or disagreement and repugnancy of any of our Ideas*. In this alone it consists” (*Essay* 4. 1. 2). Following Descartes, Locke regards the perception of the relation between ideas that is constitutive of knowledge as either direct and unmediated (that is, what Locke terms ‘intuition’) or as indirect and mediated by a chain of intuitions linking the two ideas (that is, what Locke terms ‘demonstration’ or ‘reasoning’). “In this Case, then, when the Mind cannot so bring its *Ideas* together, as by their immediate Comparison, and as it were Juxta-position, or application one to another, to perceive their Agreement or Disagreement, it is fain, by the Intervention of other *Ideas* (one or more, as it happens) to discover the Agreement or Disagreement, which it searches; and this what we call *Reasoning*. . . . Those intervening *Ideas*, which serve to shew the Agreement of any two others, are called *Proofs*; and where the Agreement or Disagreement is by this means plainly and clearly perceived, it is called *Demonstration*” (*Essay* 4. 2. 2-3).

(6) The ideas of modes are their own archetypes, but not the ideas of (material) substances. Crucial to Locke’s conception of the difference between mathematics and natural philosophy is his distinction between ideas of modes and ideas of substances. “The *complex Ideas of Substances are Ectypes, Copies* too; but not perfect ones, not *adequate*: which is very evident to the Mind, in that it plainly perceives, that whatever Collection of simple *Ideas* it makes of any Substance that exists, it cannot be sure, that it exactly answers all that are in that Substance. Since not having tried all the Operations of all other Substances upon it, and found all the Alterations it would receive from, or cause in other Substances, it cannot have an exact

adequate Collection or all its active and passive Capacities” (*Essay* 2. 31. 13). Ideas of modes and relations, for Locke, are ideas of properties and relations to which we do not attribute independent, substantial existence. As he puts it, “*Complex Ideas of Modes and Relations, are Originals, and Archetypes; are not Copies, nor made after the Pattern of any real Existence, to which the Mind intends them to be conformable and exactly to answer. . . . The Ideas therefore of Modes and Relations, cannot but be adequate*” (*Essay* 2. 31. 14).

From these principles of Locke’s epistemology, it is not difficult to deduce his distinction between mathematics and natural philosophy. The ideas involved in mathematics are ideas of modes and relations. As these are their own archetypes, they constitute what we might term an epistemically closed system. The virtue of the mathematician (which Locke recognizes that Newton possesses in abundance) is sagacity—which is the ability to take two mathematical ideas and to find a chain of intuitions that can be linked into a demonstrative relation between the ideas in question (*Essay* 4. 2. 3). Interestingly, Locke’s praise of Newton in the fourth book of the *Essay* occurs in the context of one his harangues against what he takes to be the abstract and sterile formalism of the axiomatic-deductive paradigm of *scientia*. The starting points of scientific knowledge are not the axioms or ‘maxims’, as he calls them, of the Schoolmen (or even those of the ancient geometers), but the acts of intuition by which we are able immediately to discern concrete points of agreement or disagreement between ideas. In the case of the propositions of Newton’s *Principia*, says Locke, “it was not the general *Maxims, What is, is; or The whole is bigger than a part, or the like, that help’d him*. These were not the Clues that lead him into the Discovery of the Truth and Certainty of those Propositions” (*Essay* 4. 7. 3). He continues with the wish, “Would those who have this Traditional Admiration of these

Propositions, that they think no Step can be made in Knowledge without the support of an *Axiom*, no Stone laid in the building of the Sciences without a general *Maxim*, but distinguish between the Method acquiring Knowledge, and of communicating it; between the Method of raising any Science, and that of teaching it to others as far as it is advanced” (*ibid.*).

It is clear, then, that Locke’s conception of knowledge in the strict sense, *scientia*, is an *a priori* one. *Scientia* consists of truths that are necessary in the sense of being contingent only on the content of our ideas and the necessary relations, so to speak, among those contents. Not surprisingly, mathematics is Locke’s paradigm of such a *scientia*. However, he famously (but perhaps surprisingly) argues that “*Morality is capable of demonstration*, as well as Mathematicks. For the *Ideas* that Ethicks are conversant about, being all real Essences, and such as, I imagine, have discoverable connexion and agreement with one another; so far as we can find their Habitudes and Relations, so far we shall be possessed of certain, real, and general Truths; and I doubt not . . . but a great part of Morality might be made out with that clearness, that could leave, to a considering Man, no more reason to doubt, than he could have to doubt the Truth of Propositions of Mathematicks, which have been demonstrated to him” (*Essay* 4. 12. 8).

While the *scientiae* of mathematics and morality are, as Locke would say, conversant about ideas of modes and relations—which are their own archetypes and, thus, ‘real essences’—the same is not true for natural philosophy. In the immediately succeeding section of the *Essay*, Locke claims that “in our search after the Knowledge of *Substances*, our want of *Ideas*, that are suitable to such a way of proceeding, obliges us to a quite different method. We advance not here, as in the other (where our abstract *Ideas* are real as well as nominal Essences) by contemplating our *Ideas*, and considering their Relations and Correspondencies; that helps us

very little, for the Reasons, that in another place we have at large set down” (*Essay* 4. 12. 9).

Preeminent among those reasons is Locke’s doctrine that our complex ideas of (material) substances are only ectypal and not archetypal; in other words, we have access only to the nominal essences of physical substances.

The result, as well described by Downing and other commentators, is Locke’s view that natural philosophy must largely rest content with being, in effect, natural history—which is not a true *scientia* of nature. This view is clearly and eloquently summarized in the fourth book of the *Essay*:

This way of getting, and *improving our knowledge in Substances only by Experience* and History, which is all that the weakness of our Faculties in this state of Mediocrity, which we are in in this World, can attain to, makes me suspect, that natural Philosophy is not capable of being made a Science. We are able, I imagine, to reach very little general Knowledge concerning the Species of Bodies, and their several Properties. Experiments and Historical Observations we may have, from which we draw Advantages of Ease and Health, and thereby increase our stock of Conveniences for this Life; but beyond this, I fear, our Talents reach not, nor are our Faculties, as I guess, able to advance (*Essay* 4. 12. 10).

I agree with Downing that Locke did not substantially modify his position in his later and arguable more laudatory comments on Newton’s accomplishments in his *Some Thoughts Concerning Education* or in his review of Newton’s *Principia*, if indeed he was the author of the review. In brief, Locke’s Way of Ideas epistemology precludes the possibility of mathematics imparting its scientific certainty to natural philosophy.

I conclude with brief discussions of two issues to which I do not have the time to accord the consideration that they are due. The first is the fact that Newton clearly does not share Locke’s doctrine of the relation between mathematics and natural philosophy. Even in his short

preface to the first edition of the *Principia*, Newton makes clear his view (perhaps due in part to the influence of his mentor Isaac Barrow) that “geometry is founded in mechanical practice, and is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring” (“Newton’s Preface to the First Edition, *Newton’s Principia: Motte’s Translation Revised*, ed. F. Cajori [University of California Press, 1971], vol. 1, xvii). So the connection between mathematics and natural philosophy is deep and, as it were, axiomatic for Newton.

Newton’s primary interests lay in mathematics and (*pace*, Locke) natural philosophy. Insofar as he was interested in metaphysics, his interest was largely confined to *metaphysica specialis* or theology, not to *metaphysica generalis*. And, beyond his obvious concern with scientific methodology, he evidences little interest in systematic epistemology. This limitation—if limitation it is—probably saved him from what might be termed the foundational problems for the application of mathematics to natural philosophy attendant on the Way of Ideas epistemology regnant on both sides of the English Channel. In his splendid recent book (*Isaac Newton on Mathematical Certainty and Method* [The MIT Press, 2009]), Niccolò Guicciardini documents Newton’s proclivity for the foundational mathematical doctrines of the ‘ancients’, remarking that “it seems to me that Newton conflated these two different conceptions of analysis and synthesis (the Pappian and the Aristotelian) as a rhetorical move aimed at defending the certainty of his natural philosophy” (324). I would add only that an Aristotelian *ontology* of mathematics, according to which the object of mathematics is the physical, sensible world—but not *qua* physical or sensible—would seem much more congenial to Newton’s purposes than some form of mathematical Platonism.

Finally, I return to those eighteenth-century Newtonians, such as Desaguliers (and, for that matter, Voltaire), who were so eager to enroll Locke posthumously in their ranks. Mordecai Feingold has shown (“Mathematicians and Naturalists: Sir Isaac Newton and the Royal Society,” in *Isaac Newton’s Natural Philosophy*, ed. J. Z. Buchwald and I. B. Cohen [The MIT Press, 2001], 77-102) how important the tension between the naturalists or natural historians and the philomaths was in the history of the Royal Society. This tension particularly erupted (after the death of Newton in 1727) in the election for the presidency of the Royal Society contested by Martin Fowlks, “Newton’s heir presumptive” (Feingold, 77) and candidate of the philomaths (who, by this time, were virtually all Newtonians), and by Sir Hans Sloane, the candidate of the naturalists. Sloane narrowly prevailed, but, in the words of Feingold, the philomaths’ “ringleaders remained recalcitrant” (*ibid.*). It seems clear, at least with respect to the theory of *An Essay Concerning Human Understanding*, that John Locke’s affinities were with the naturalists—at least if their natural history could be translated into the “Advantages of Ease and Health, and thereby increase our stock of Conveniences for this Life” (*Essay* 4. 12. 10). What a coup, then, if the philomaths could conscript the authority of Locke, the ‘second great man’ of the late seventeenth century, as the “first who became a Newtonian Philosopher without the Help of Geometry”!

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