THE FLOW OF INFLUENCE: FROM NEWTON TO LOCKE … AND BACK

by Steffen Ducheyne[1]

> Who knows not what odd notions many men's heads are filled with, and what strange ideas all men's brain are capable of[2]?

1. The Flow of Influence

As G.A. John Rogers has noted, most of the literature on Locke-Newton assumes that the flow of influence goes from Newton to Locke[3]. Rogers himself has repeatedly claimed that Newton did not significantly influence Locke's *Essay concerning Human Understanding* and that Locke did not feel himself required to review his philosophical position in the light of Newton's work[4]. Locke found in the *Principia* «the exemplification of a method to which he himself already subscribed», i.e. a combination of observation, generalization, induction and deduction[5]. Locke, as Rogers states correctly, only read the first edition of the *Principia* (1687) – Locke died in 1704. As Locke only knew this edition, he was not affected by the philosophical and theological doctrines of the *General Scholium* in the second edition (1713), Rogers claims. Even if granting this, this does not imply that all has been said about the exchange of

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2. John Locke, *An Essay concerning Human Understanding*, Edited with an Introduction by Peter H. Nidditch (Clarendon Press, Oxford 1979), p. 248. Henceforth this edition is referred to as "Locke, *Essay*".

3. See: G.A. John Rogers, *Locke's* Essay *and Newton's* Principia, «Journal of the History of Ideas» 1978 (39, 2), pp. 217-232, pp. 217-220 (notes 1-7), for the references.

4. G.A. John Rogers, *The System of Locke and Newton*, in: *Contemporary Newtonian Research*, Zev Bechler (Ed.) (D. Reidel Publishing Company, Dordrecht/Boston/London 1982), pp. 215-238.

5. Id., *Locke's* Essay *and Newton's* Principia, cit., p. 229.

thought between Newton and Locke. The following questions deserve our consideration: (i) does Rogers' claim stand the test of Locke's *corpus*?, (ii) what about Newton's influence on the second and third edition of the *Essay* (Rogers grants an influence on the fourth, but tends to minimize it)?, and (iii) what about Locke's influence on Newton? In this essay, it is shown that the flow of influence went in both directions: Newton's *scholium* on space and time influenced Locke significantly (*pace* Rogers' account[6]) and Newton was inspired by Locke's empiricism and more specifically by his anti-innativism. There were thus mutual influences.

One *caveat*: nowhere in this essay is it claimed that Locke was a 'Newtonian' – this is clear from the discussion in the third part. Lisa Downing has rightly stressed that Locke remained more sceptical about the results of Natural Philosophy than Newton, for, though he held it as an intelligible theory that accorded with the concept of body we distil from sense experience, he remained sceptical about the possibility of rendering Natural Philosophy as a *scientia*[7]. By contrast, Newton thought that Natural Philosophy establishes truth, certainty and causes[8]. Furthermore, the details of Locke's opinion on scientific methodology, induction and deduction form phenomena (which were crucial to Newton) are lacking.

Not all of the parallels we shall discuss are the result of a process of influence, for Locke and Newton shared identical views developed independently of each other. We begin this essay by looking at the basics of Locke's epistemology in order to set the stage for the second and third sections.

2. Locke's Epistemology

Locke's method in his *Essay on Human Understanding* (1689)[9] proceeded

6. G.A. John Rogers, *The System of Locke and Newton*, cit., p. 216.

7. Lisa Downing, *Locke's Newtonianism and Lockean Newtonianism*, «Perspectives on Science» 1997 (5), pp. 285-310; cf. p. 307.

8. Steffen Ducheyne, *Newton's Training in the Aristotelian Textbook Tradition: From Effects to Causes and Back*, «History of Science» 2005 (43), pp. 217-237.

9. Locke's *magnum opus* was long in the making: Locke began working on it after 1671 (as Draft A, *Intellectus humanus cum cognitionis certitudine, et assensus firmitate*, testifies). Draft B, which Locke also began composing in 1671, was written shortly after Draft A. See: Jonathan Walmsley, *Locke's Natural Philosophy in Draft A of the* Essay, «Journal for the History of Ideas» 2004 (56), pp. 15-37, for an excellent account of Draft A. Draft C was composed in 1684. See Roger Woolhouse, *Locke, A Biography* (Cambridge University Press, Cambridge 2006), pp. 98-105, pp. 106-109, pp. 199-200, pp. 247-248 for the details on these drafts. See Esmond S. de Beer, *The Correspondence of John Locke* (8 vol.) (Clarendon Press, Oxford 1976-1989), vol. II, Letter 801 (Locke to Edward Clarke 22 December 1684/1 January 1685), pp. 671-672, p. 671, vol. III, Letter 881 (Locke to Edward Clarke, 7/17 December 1686), pp. 78-80, p. 79, Letter 886 (Locke to Edward Clarke, 21/31 December 1686, pp. 88-89, p. 89, Letter 994 (Locke to Benjamin Furly, 9/19 February 1688), pp. 330-334, p. 332, Letter 999 (Locke to Edward Clarke, 27 January/6 February

as follows: (i) first, the origin of ideas[10] is inquired, (ii) next, the knowledge that is provided by ideas, and, (iii) finally, the nature and grounds of faith[11]. The fundamentals of Locke's epistemology can be found in Book II, entitled *Of Ideas*, and Book IV, entitled *Of Knowledge and Probability*. The two remaining books are only tangentially discussed here – Book I rails at innate ideas and Book III dealt with words and language.

Book II consists of thirty-three chapters (in its latest edition). According to Locke, the materials of thinking, or as he refers to them, the «fountains of knowledge» stem either from *experience*, i.e. knowledge directly provided by the senses («extrinsical knowledge»), or from the *inner sense* (also called «reflection»), i.e. knowledge as the result of the cognitive process of reflecting on the inner operations of the human mind («intrinsical knowledge»)[12]. In the *pars destruens* (Book I), Locke argues that the assumption of innate ideas is neither justified nor useful in epistemology. Self-evident maxims, for instance, which are universally assented to[13] are, as Locke points out, few and completely useless for discovering (new) knowledge and only have a pedagogical and argumentative value:

> Mr. *Newton* [or the «incomparable Mr. Newton»[14]], 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: But, for the Discovery of these, it was not the general *Maxims*, *What is, is*; or, *The whole is bigger than a part*, or the like, that help'd him[15].

1688), pp. 343-353, p. 351. An abstract of the *Essay* appeared in: John Locke, *Extrait d'un livre anglois qui n'est pas encore publié, intitulé Essai philosophique concernant l'entendement, où l'on montre quelle est l'étenduë de nos connoissances certaines, & la maniere dont nous y parvenons, Communique par Monsieur Locke*, translated by Jean Le Clerc, «Bibliothèque Universelle & Historique» 1688 (8), pp. 49-142. Locke published four editions of the *Essay*: in 1689, 1694, 1695, and 1700.

10. On Locke's concept of ideas, see Vere Chappell, *Locke's Theory of Ideas*, in: *The Cambridge Companion to Locke*, Vere Chappell (Ed.) (Cambridge University Press, Cambridge 1994), pp. 26-55.

11. Locke, *Essay,* cit., I.i, § 3, p. 44.

12. *Ibid.,* cit., II.i, §§ 3-4, pp. 104-105, § 24, pp. 117-118, II.vii, § 10, p. 131. According to Locke *extrinsical* knowledge understanding is merely passive (*ibid.*, II.i, § 25, p. 131). This distinction is already present in Draft A (John Locke, *Drafts for the Essay concerning Human Understanding*, edited by Peter H. Nidditch and G.A.J. Rogers (3 vol.) (Clarendon Press, Oxford 1990), vol. 1 *Drafts A and B*, pp. 1-11 [henceforth: "Locke, *Draft A*" or "Locke, *Draft B*"] and is preserved in Draft C (*ibid.*, pp. 128-133).

13. Locke, *Essay*„ cit., I.ii, § 4, p. 49. Not even the idea of God is innate, but follows *a posteriori* from the «visible marks of extraordinary Wisdom and Power» (*ibid.,* I.iv, §9, p. 89)

14. *Ibid.,* I.i, [§ 6], p. 10.

15. Locke, *Essay*, cit., IV.vii, § 11, p. 599. Compare with: «Such is the admirable discovery of Mr. Newton, that all bodies gravitate to one another, which may be counted as the basis of natural philosophy, which of what use it is to the understanding of the great frame of our solar system, he has to the astonishment of the learned world shewn, and how much farther it would guide us in other things, if rightly pursued, is not yet known.» (Thomas

Let us probe further into the essentials of Locke's epistemology as found in Book IV of Locke's *Essay*, which contains twenty-one chapters in its latest edition. According to Locke, knowledge is «the perception of the connection of and agreement, or disagreement and repugnancy of any of our Ideas»[16]. Such connection referred to either: (1) *identity* or *diversity* (e.g. in the statement «What is, is.» or «The same thing cannot be and not be.»), (2) *relation* (between two or more ideas), (3) *co-existence or necessary connexion* (e.g. the fact that gold is fixed), and (4) *real existence*, which occurs when an actual real existence agrees to an idea[17]. We can have knowledge of our own existence, of God's existence, and of the existence of other things (i.e. the existence of the external world)[18]. The perception of truth by human beings comes of two sorts: by bare intuition or «without the intervention of any other *Idea*»[19] (corresponding to simple ideas) or indirectly by the intervention of other ideas (corresponding to complex ideas, which can be reduced to three classes: modes, substance and relations[20]). The former Locke qualifies as «the clearest, and most certain [knowledge], that humane Frailty is capable of»[21]. Truth comes in two kinds: mental truth, i.e. truth by the mind perceiving without words, and verbal truth, i.e. truth when words function as the sings of our ideas. In line with his empiricism, Locke endorses the view that the clearness of intuition or lack of it «consists in the clearness or obscurity of that Perception, and not in the clearness or obscurity of the *Ideas* themselves»[22]. Correspondingly, Locke notes that «'Tis on this *Intuition* that depends all the Certainty and Evidence of all our Knowledge»[23]. Intuition is like a «bright Sunshine»[24] which illuminates reality. The latter, indirect knowledge, Locke considers as reasoning and it is labelled «demonstrative knowledge». Inference is then described by Locke as «the Perception of the connexion there is between the *Ideas*, in each step of the deduction»[25]. Locke observes on reasoning:

> Though where-ever the Mind perceives the Agreement or Disagreement of any of its *Ideas*, there be certain Knowledge; Yet it does not always happen, that the Mind sees

Fowler, *Locke's Conduct of Understanding, with introduction, notes, etc.* [originally Locke's 1706 posthumous *Of the Conduct of Understanding*] (2nd edition) (Clarendon Press, Oxford 1882), p. 95). Locke wrote an anonymous review of the *Principia* (John Locke, Review of *Philosophiæ naturalis principia mathematica*, «Bibliothèque Universelle et Historique» 1688 (8), pp. 436-450; also see: J. L. Axtell, *Locke's review of the* Principia, «Notes and records of the Royal Society of London» 1965 (20), pp. 152-161). Locke's review is a rather dull summary of the *Principia*.

16. *Ibid.,* IV.i, § 2, p. 524, *cf*. Locke's definition of truth in *ibid*., IV.vi, § 9, p. 578.
17. *Ibid.,* IV.iii, §§ 8-20, pp. 543-552.
18. *Ibid.,* IV.ix-xi, § 2, p. 618; *ibid*., IV.ix-xi, pp. 618-639.
19. *Ibid.,* IV.ii, § 1, p. 531.
20. *Ibid.,* II.xii, §§ 3-7*,* pp. 165-166.
21. *Ibid.*, IV.ii, § 1, p. 531.
22. *Ibid.,* IV.ii, § 15, p. 538.
23. *Ibid.* IV.ii, § 1, p. 531.
24. *Ibid*.
25. *Ibid.,* IV.xvii, § 2*,* p. 669.

that Agreement or Disagreement, which there is between them, even where it is discoverable; and in that case, remains in Ignorance, and at most gets no further than a probable conjecture[26].

It should be noted that intuition is not restricted to our ideas of extension, figure, number, and their modes[27], but also concerns sensations produced in us, i.e. secondary qualities:

But in other simple *Ideas*, whose Modes and Differences are made, and counted by degrees, and not quantity, we have not so nice and accurate a distinction of their differences, as to perceive, or find ways to measure, their just Equality, or the least Differences. *For those other simple* Ideas*, being appearances of sensations produced in us, by the Size, Figure, Number and Motion of minute Corpuscles singly insensible*; their different degrees also depend upon the variation of some, or all of those Causes; which since it cannot be observed by us, in Particles of Matter whereof each is too subtile to be perceived it is impossible for us to have any exact Measures of the different degrees of these simple *Ideas*[28].

Secondary qualities are produced by modifications of matter in the bodies that cause perceptions in us[29]. The precise link between these qualities is unknown, since:

[O]ur Minds not being able to discover any *connexion* betwixt these primary qualities of Bodies and the sensations that are produced in us by them, we can never be able to establish certain and undoubted Rules of the Consequence or Co-existence of any secondary Qualities, though we could discover the size, figure, or motion of those invisible Parts which immediately produce them[30].

Only the primary qualities objectively exist (i.e. without perceivers); the secondary qualities are modes of the primary ones[31]. Locke further distinguishes «powers» (or 'dispositions' in modern terminology) which are primary qualities which affect the primary qualities of other objects so that they in their turn affect the secondary qualities[32]. Moreover:

Herein therefore is founded the *reality* of our Knowledge concerning *Substances*, that all our complex *Ideas* of them must be such, and such only, as are made up of such simple ones, as have been discovered to co-exist in Nature. *And our* Ideas *thus being true, though not, perhaps very exact Copies, are yet the Subjects of real (as far as we have any)* Knowledge *of them*[33].

26. *Ibid.,* IV.ii, § 2*,* p. 531.
27. *Ibid.,* IV.ii, § 9*,* pp. 534-535.
28. *Ibid.,* IV.ii, § 11*,* p. 535.
29. *Ibid.,* II.viii, § 7*,* p. 134.
30. *Ibid.,* IV.viii, § 13*,* p. 545.
31. *Ibid.,* II.viii, §§ 17-18, pp. 137-138.
32. *Ibid.,* II.viii, § 23, pp. 140-141.
33. *Ibid.,* IV.iv, § 12*,* p. 568 [emphasis added].

Locke adds that we cannot have intuitive knowledge of all our ideas, only of the simple ideas provided by perception, as «we cannot examine and perceive all the Relations they have one to another, by *juxta*-position, or an immediate comparison one with another»[34]. (There is a small problem (or at least a lacuna) here, for Locke readily admits that geometry is independent of the existence of geometrical figures and its demonstrations are the same whether a triangle exists or not[35]. However, if geometrical figures do not exist (and cannot be perceived), it is impossible for them to be derived form perception. If they are the result of a process of abstracting from empirical knowledge, Locke does not specify how this process works.)

Several phenomena are inaccessible to our understanding:

> But [i] the coherence and contiguity of the parts of Matter; [ii] the production of sensation in us of Colours and Sounds, *etc*. by impulse and motion; [iii] nay, the original Rules and Communication of Motion being such, wherein we can discover no natural connexion with any *Ideas* we have, we cannot but ascribe them to the arbitrary Will and good Pleasure of the Wise Architect[36].

The key element of the theory of universal gravitation, attraction, surpasses our comprehension. In a draft-version of his review of the *Principia* Locke wrote on attraction «Quid velit author per attractionem ex ipsis verbis dignosci potest»[37].

In particulars our knowledge begins and it spreads itself to generals (therefore general or universal words do not belong to the real existence of things[38])[39]. Our knowledge, although it can progress, cannot exceed our ideas «either in extent, or perfection»[40]. Reasoning, which involves complex ideas, hinges on words (the «*Signs of internal Conceptions*»[41] rather than on ideas)[42]. Therefore Locke concludes that one ought to «quit the common notion of Species and Essences»[43]. Locke observes:

> *All our complex* Ideas, *except those of Substances*, being *Archetypes* of the Mind's own making, not intended to be the Copies of any thing, nor referred to the existence

34. *Ibid.,* IV.iii, § 3*,* p. 539.
35. *Ibid.,* IV.iv, § 8, p. 566.
36. *Ibid.,* IV.iii, § 29*,* pp 559-560 [numberings added]. See Michael Jacovides, *The Epistemology under Locke's Corpuscularianism*, «Archiv für Geschichte der Philosophie» 2002 (84), pp. 161-189 and Margaret D. Wilson, *Superadded Properties: The Limits of Mechanism in Locke*, «American Philosophical Quarterly» 1979 (16), pp. 143-150, for useful discussion.
37. Bodleian Oxford, MS. Locke c. 31 (quoted from Axtell, *Locke's review of the Principia*, cit., p. 155).
38. Locke*, Essay*, cit., III.iii, § 11, p. 414.
39. *Ibid.,* IV.vii, § 11*,* p. 603.
40. *Ibid.,* IV.iii, § 3, p. 539.
41. *Ibid.,* III.i, § 2*,* p. 402.
42. *Ibid.,* IV.v, § 4*,* p. 574.
43. *Ibid.,* IV.iv, § 16, p. 573.

of any thing, as to their Originals, *cannot want any conformity necessary to real Knowledge*[44].

Furthermore, we cannot know the true essences of things:

For how can we be sure that this or that quality is in *Gold*, when we know not what is or is not *Gold*? Since in this way of speaking, nothing is *Gold* but what partakes of an Essence, which we, not knowing, cannot know where it is, or is not, and so cannot be sure, that any parcel of Matter in the World is or is not in this sense *Gold*; being incurably ignorant, whether it has or has not that which makes anything to be called *Gold*, *i.e.* that real Essence of *Gold* whereof we have no *Idea* at all. This being as impossible for us to know as it is to a blind Man to tell in what Flower the Colour of a *pansie*, is or is not to be found, whilst he has no *Idea* of the Colour of a *pansie* at all[45].

Likewise, the idea of substance is «an uncertain supposition of we know not what; (*i.e.* of something whereof we have no particular distinct positive) *Idea*, which we take to be the *substratum*[46], or support, of those *Ideas* we do know»[47]. Therefore, philosophers who try to unravel essences are on the wrong track:

A Painter or Dyer, who never inquired into their causes, hath the *Ideas* of White and Black, and other Colours, as clearly, perfectly, and distinctly in his Understanding, and perhaps more distinctly, than the Philosopher, who hath busied himself in considering their Natures, and thinks he knows how far either of them is in its cause positive or privative; and the *Idea of Black* is no less *positive* in his Mind than that of White, *however the cause* of that Colour in the external Object may *be only a privation*[48].

«Essences» amount to nothing more than:

That Men making abstract *Ideas*, and settling them in their Minds, with names annexed to them, do thereby enable themselves to consider Things, and discourse of them, as it were in bundles, for the easier and readier improvement, and communication of their Knowledge […][49].

Hence Locke's frequent stress on human ignorance expressed in, for instance, the following passages:

I think not only, that it becomes the Modesty of Philosophy, not to pronounce Magisterially, where we want that Evidence that can produce knowledge; but also, that it is of use to us, to discern how far our Knowledge does reach; […][50].

44. *Ibid.,* IV.iv, § 5, p. 564.
45. *Ibid.,* IV.vi, § 5*,* p. 581.
46. On Locke's notion of substratum, see: Lex Newman, *Locke on the Idea of Substratum*, «Pacific Philosophical Quarterly» 2000 (81), pp. 291-324 and Jonathan Bennett, *Substratum*, in: *Locke*, Vere Chappell (Ed.) (Oxford University Press, Oxford 1998), pp. 129-148.
47. Locke*, Essay*, cit. I.iv, § 18*,* p. 95.
48. *Ibid.,* II.viii, § 3, p. 133.
49. *Ibid.,* III.iii, § 20, p. 420.
50. *Ibid.,* IV.iii, § 6, p. 542.

But though we are not without *Ideas* of these primary qualities of Bodies in general, yet not knowing what is the particular *Bulk*, *Figure*, and *Motion*, of the greatest parts of the Bodies of the Universe, we are ignorant of the several Powers, Efficacies, and Ways of Operation, whereby the Effects, which we daily see, are produced[51].

All that I shall say for the Principles I proceed on, is, that I can only *appeal* to Mens own unprejudiced *Experience*, and Observation, whether they be true, or no; and this is enough for a Man who professes no more than to lay down candidly and freely his own Conjectures, concerning a Subject lying somewhat in the dark, without any other design, than an unbias'd enquiry after Truth[52].

Understanding is like a «Closet wholly shut from light, with only some little openings left, to let in external visible Resemblances, or *Ideas* of things without»[53]. Since we haven't a clue about these primary qualities, *real essences* are not knowable (except by revelation[54]) and the most certain knowledge consists in knowing the *nominal essences*[55]. Nominal essences refer to the properties of real (presupposed) essences, which in their turn depend on «*the real Constitution of Things*»[56]. For instance, the nominal essence of gold includes that it is yellow, malleable, fusible, fixed, etc. The real essences are the inaccessible particles constituting gold. Locke notes that a perfect science of natural bodies is impossible[57] and that all natural things have a real but unknown constitution of insensible parts[58].

3. Locke's Essay and Newton's *Principia*

In the remainder of this paper, several new perspectives on the Newton-Locke interaction are argued for. Here we shall consider: their doctrines of space and time and God's relation to space and time, their views that God cannot move bodies nor can be moved by bodies, their anti-essentialist account of God, and, finally, their critique of Descartes' innativism.

In Chapters IV to XXVIII in Book II, Locke expands on the origin of several of our ideas and the relations between them. We shall focus here on his

51. *Ibid.,* IV.iii, § 24, p. 555.
52. *Ibid.,* I.vi, § 25*,* p. 102.
53. *Ibid.,* II.xii, § 17*,* p. 163.
54. *Ibid.,* IV.iii, § 27, p. 558.
55. *Ibid.,* III.iii*,* §§ 15-20, pp. 417-420. See: Margaret Atherton, *The Inessentiality of Lockean Essences*, in: *Locke*, Vere Chappell (Ed.) (Oxford University Press, Oxford 1998), pp. 199-213.
56. Locke*, Essay*, cit., III.ix, § 12*,* p. 482. For some problems of Locke's notion of nominal essence, see Dan Kaufman (2007), *Locke on individuation and the corpuscular basis of kinds*, «Philosophy and Phenomenological Research» 2007 (75), pp. 499-534.
57. Locke*, Essay*, cit. IV.iii, § 29, p. 560.
58. *Ibid.*, III.iii, § 15, p. 417. Newton had similar concerns. For an elaborate analysis, see Steffen Ducheyne, *The General Scholium: Some Notes on Newton's Published and Unpublished Endeavours*, «Lias: Sources and Documents Relating to the Early Modern History of Ideas» 2006 (33), pp. 223-274, pp. 228-237.

treatment of the ideas of space, time[59], and God (and our ignorance God's substance and substances[60] in general). Locke's account of space and time, *as from the second edition onwards*, was influenced by Newton, I claim[61]. Locke and Newton became well acquainted from 1689 onwards and corresponded frequently from then on[62]. Newton sent a copy of his anti-Trinitarian *Two notable corruptions* to Locke in 1690, a token of his trust in Locke[63]. During their meeting in 1689, Newton had suggested, according to his later statements after Locke's death, to Locke that «one could in some fashion form an idea of the creation of matter by supposing that God could through his power prevent everything from entering a certain portion of pure space, space being by its very nature penetrable, eternal, necessary, infinite; for thereafter that portion of space would posses impenetrability, which is one of the essential qualities of matter»[64]. This is important information, as it suggests that Newton and Locke discussed the status of space and time and God's relation to space and time. Rogers sees Locke as a defender of «a relativist view of space and time»[65] and claims that Locke never accepted Newton's absolutist position on space and time[66]. This claim does not stand close scrutiny for there is textual evidence that he did from the second edition onwards.

It is true that in the *Essay* Locke noted that «our *Idea* of Place, is nothing else, but such a relative Position of any thing»[67]. Note, however, that this state-

59. In Draft A (but not in Draft B) there is a brief discussion on the possibility of a void, but not about absolute space (Locke, *Draft A*, cit. pp. 45-46). In Draft B there is a small discussion about time. Locke wrote: «[t]ime therefor to duration is as place to extension which is noe thing but examining or assigneing the distance of any two points by some common knowne measure» (Locke, *Draft B*, cit. p. 225, *cf.* p. 232). On time Locke observed that «[t]he Idea of Duration being taken from reflection on the succession of the Ideas in our owne mindes the measure of it from some observable equall periods» (*ibid.*, p. 249). Space and time were also considered infinite (*ibid.*).

60. See Michael Ayers, *Locke* (2 vols.) (Routledge, London and New York, 1991), vol. II, pp. 39-64, pp. 91-128. For the criticism of Locke's contemporaries on his notion of substance, see Edwin McCann, *Locke's Theory of Substance under Attack!*, «Philosophical Studies» 2001 (106), pp. 87-105.

61. I have checked against the original copies of the first and second edition of Locke's *Essay* (John Locke, *An Essay concerning Human Understanding* (Printed for Thomas Basset, and sold by Edw. Mory at the Sign of the Three Bibles in St. Paul's Church-Yard, London 1690) and John Locke, *An Essay concerning Human Understanding* (Printed for Thomas Dring, at the Harrow, over-against the Inner-Temple Gate in Fleet-street; and Samuel Manship, at the Ship in Cornhill, near the Royal Exchange, London 1694), pp. 81-104.

62. Rogers, *Locke's Essay and Newton's Principia*, cit., pp. 230-232.

63. A. Rupert, Hall and Laura, Tilling (Eds.), *The Correspondence of Isaac Newton* (7 vol.) (Cambridge University Press, Cambridge 1975), vol. III, p. 82. *Cf.* Stephen D. Snobelen, *Isaac Newton, heretic: the strategies of a Nicodemite*, «British Journal for the History of Science» 1999 (32), pp. 381-419, pp. 401-402.

64. Quoted from Woolhouse, *Locke, A Biography*, cit., p. 279.

65. Rogers, *The System of Locke and Newton*, cit. p. 236-237 (note 27).

66. Rogers, *Locke's* Essay *and Newton's* Principia, cit., p. 221.

67. Locke, *Essay*, cit., II.xiii, § 10, p. 171, cf. *ibid*., § 9, p. 170.

ment occurs at the very beginning of Locke's discussion of space and time. Throughout his discussion of space and time Locke shows that our simple ideas of space and time can be extended *in infinitum* and that space and time should have an intrinsic and absolute, though *unknowable*, metric. In other words, he shows that from a relative conception of space and time we can arrive at an absolute conception of space and time. Locke claims that once we have formed the simple ideas of space and time we can extend these up to infinity[68]. There cannot be an end to this process of extending space, otherwise we «confine GOD within the limits of Matter»[69]. Hence, the idea of relative space is but one of the «Modifications of the Idea of Space». In Chapter IV, entitled *Idea of Solidity*, which is more or less identical in all four editions, Locke states that our Idea of Solidity and our Idea of (pure) Space are distinct, for men can imagine «two Bodies at a distance, so as they may approach one another, without touching or displacing any solid thing»[70] and natural philosophy shows that bodies mutually attract one another *in vacuo* «which is unexplicable by us»[71]. According to Locke, the idea of a vacuum is admissible, for if God were to annihilate everything in the universe a vacuum would remain[72]. Moreover, the possibility of motion in itself proves a vacuum: Locke notes that if «the least Particle of the Body divided is as big as a Mustard-seed, a void Space equal to the bulk of a Mustard-seed be requisite to make room for the free motion of the Parts of the divided Body within the bounds of its Superficies»[73]. On the Ideas of Solidity and Space Locke wrote:

> Motion can neither be, nor be conceived without Space; and yet Motion is not Space, nor Space Motion: Space can exist without it, and they are very distinct *Ideas*; and so, I think, are those of Space and Solidity. Solidity is so inseparable an *Idea* from Body, that upon that depends its filling of Space, its Contact, Impulse, and Communication of Motion upon Impulse. And if it be a Reason to prove, that Spirit is different from Body, because Thinking includes not the *Idea* of Extension in it; the same Reason will be as valid, I suppose, to prove that *Space is not Body*, because it includes not the *Idea* of Solidity in it; *Space and Solidity* being *as distinct Ideas*, as Thinking and Extension, and as wholly separate in the Mind one from another[74].

Locke stated three additional arguments in favour of the distinctness of the Idea of Space and the Idea of Solidity. Body and extension are not the same, since:

68. *Ibid.*, II.xiii, § 20, p. 176, cf. *ibid.*, II.xv, §§ 2-3, pp. 196-197, cf. *ibid.*, II.xv, § 9, p. 202, II.xvii, §§ 4-22, pp. 211-223.

69. *Ibid*., II.xiii, § 2, p. 197. Cf.: «GOD, every one easily allows, fills Eternity; and 'tis hard to find a Reason, why any one should doubt, that he likewise fills Immensity: His infinite Being is certainly boundless one way as another, and methinks it ascribes a little too much to Matter, to sat, where there is no Body, there is nothing.» (*ibid.*, II.xiii, § 3, p. 197).

70. *Ibid.,* II.iv, § 3*,* p. 124.

71. H. Woodfall *e.a.* (Eds.), *The Works of John Locke* (4 vol.) (Rivington, London 1768), vol. IV, p. 581.

72. Locke*, Essay*, cit., II.xiii, § 21*,* pp. 176-177.

73. *Ibid.,* II.xiii, § 22*,* p. 177.

74. *Ibid.*, II.xiii, § 11, p. 172.

(i) «*Extension* [i.e. pure Space] includes no Solidity, nor resistance to the Motion of *Body*, as Body does»[75]. Pure Space does not offer resistance to the material objects contained in it.
(ii) «The Parts of pure Space are inseparable one from the other; so that Continuity cannot be separated, neither really, nor mentally»[76]. While material objects can be separated, pure Space cannot be mentally or actually separated otherwise we would obtain «two Superficies, where before there was a Contiguity»[77]. In other words, pure Space is *homogeneous*.
(iii) «The parts of pure *Space*, are immovable, which follows from their inseparability; *Motion* [in the relative sense] being nothing but change of distance between any two things: But this cannot be between Parts that are inseparable; which therefore must needs be at perpetual rest one among another»[78]. In other words, the pure Space in which the motions of material bodies take place is fixed as the parts constituting it are immovable and thus in absolute rest.

Locke did not use the terms 'absolute space' or 'absolute time'. However, he did call space, conceived *vulgarly*, as «nothing else but such a relative Position of any thing»[79] and he distinguished between «space» and «pure space» and between «time» and «pure time». Locke wrote that relative time is «Duration, as set out by certain Periods, and marked by certain Measures or *Epochs*»[80]. In addition, he wrote:

> For Duration and Space being in themselves uniform and boundless, the Order and Position of things, without such known settled Points, would be lost in them; and all things would lie jumbled in an incurable Confusion[81].

Locke also noted that «We must therefore carefully distinguish betwixt Duration it self, and the measures we make use of to judge of its length. Duration, in itself, is to be considered as going on in one constant, equal, uniform Course: but none of the measures of it which we make use of can be *known* to do so»[82]. Locke thus claimed that relative measures of duration of space should be distinguished from pure Duration and pure Space, respectively[83].

75. *Ibid.,* II.xiii, § 12, p. 172.
76. *Ibid.*, II.xiii, § 13, p. 172.
77. *Ibid.*
78. *Ibid.,* II.xiii, § 14*,* p. 173.
79. *Ibid.,* II.xiii, § 10*,* p. 171.
80. *Ibid.,* II.xiv, § 17*,* p. 187.
81. *Ibid.*, II.xv, § 5, p. 199.
82. *Ibid.,* II.xiv, § 21*,* p. 190.
83. Locke was quite sceptical about the possibility of measuring absolute motion. Newton, by contrast, suggested that the case was not utterly hopeless: «For example, if two balls, at a given distance from each other with a cord connecting them, were revolving about a common centre of gravity, the endeavor of the balls to recede from the axis of motion could be known from the tension of the cord and thus the quantity of circular motion

Relative measures (e.g. days, years, inches, yards, etc.) are «determinate distinguishable Portions of those infinite Abysses of Space and Durations»[84]. In defence of his thesis on absolute time, Locke argues that we can imagine duration where nothing does really endure or exist[85]. Duration or succession is a «common measure of *all* Existence whatsoever, wherein all things whilst they exist, *equally partake*»[86]. On the assumption of only relative time, no objective framework of time could be given (*cf.* Newton's concerns with Descartes' views) or as Locke formulated it «[w]ithout some such fixed Parts or Period, the Order of things would be lost»[87].

Let us consider the essentials of Newton's *scholium* on space and time. In the *scholium* following the definitions (which includes the definitions of mass, quantity of motion, inherent force, impressed force, and centripetal force), Newton discusses absolute space and time[88]. There he wrote as follows[89]:

Thus far it has seemed best to explain the senses in which less familiar words are to be taken in this treatise. Although time, space, place and motion are very familiar to everyone, it must be noted that these quantities are popularly conceived solely with reference to the objects of sense perception. And this is the source of certain preconceptions; to eliminate them it is useful to distinguish these quantities into absolute and relative, true and apparent, mathematical and common.
1. *Absolute, true, and mathematical time*, in and of itself and of its own nature, without reference to anything external, *flows uniformly and by another name is called duration*. *Relative time, apparent, and common time is any sensible and external measure of duration by means of motion*; *such a measure – for example a month an hour a day – is commonly used instead of true time*.

could be computed. Then, if any equal forces were simultaneously impressed upon the alternate faces of the balls to increase or decrease their circular motion, the increase or decrease of the motion could be known from the increased or decreased tension of the cord, (…). In this way both the quantity and the direction of circular motion could be found in any immense vacuum, where nothing external and sensible existed with which the balls could be compared.» (Isaac Newton, *The Principia, Mathematical Principles of Natural Philosophy*, A New Translation by I. Bernard Cohen and Anne Whitman, assisted by Julia Budenz, Preceded by A Guide to Newton's Principia by I. Bernard Cohen (University of California Press, Berkeley/Los Angeles/London 1999), p. 414).

84. Cf. Locke, *Essay*, cit., II.xv, §§ 6-7, pp. 199-200.

85. *Ibid*., II.iv § 3, p. 124. In earlier work (in his notes, dated 27 March 1676) he denied that such «imaginary» time is «any thing reall, or positive» (R.I. Aaron and Jocelyn Gibb, *An Early Draft of Locke's Essay together with Excerpts from his Journals* (Clarendon Press, Oxford 1936), p. 77). His doctrine of space grew out of his dissatisfaction with Cartesianism (*ibid.*, p. 100). His main contention at this stage was that space is not identical to extension, but he did not consider the possibility of absolute space.

86. Locke, *Essay*, cit., II.xv, § 11, p. 203 [emphasis added].

87. *Ibid.*, II.xv, § 7, p. 200.

88. *Ibid.*, pp. 408-415.

89. We shall not dwell here on the differences between this *scholium* and *De Gravitatione*, *Tempus et Locus*, *The Opticks*, the Leibniz-Clarke correspondence. See especially: James E. McGuire, *Tradition and Innovation, Newton's Metaphysics of Nature* (Kluwer, Dordrecht 1995).

2. Absolute space, of its own nature without reference to anything external, always remains *homogeneous and immovable* [cf. (ii) and (iii)]. *Relative space is any movable measure or dimension of this absolute space*; *such a measure or dimension is determined by our senses from the situation of space with respect to bodies* and is popularly used for immovable space, as in the case of space under the earth or in the air or in the heavens, where the dimension is determined from the situation of the space with respect to the earth. Absolute and relative space are the same in species and in magnitude, but they do not always remain the same numerically. For example, if the earth moves, the space of our air, which in a relative sense and with respect to the earth always remains the same, will now be one part of the absolute space into which the air passes, now another part of it, and thus will be changing continually in an absolute space[90].

Newton stated that local motions are referred to the parts of space, which does not impede bodies – which agrees with (i)[91]. This scholium is present from the first edition of the *Principia* and is clearly metaphysical in nature (*cf.* the statements «in and of itself and of its own nature, without reference to anything external», «Absolute space, …, always remains homogeneous and immovable» or the idea that, when considering true space and time, we should abstract from the objects of sense perception[92]), *pace* G.A.J. Rogers who writes that «[t]he full metaphysical and theological implications of Newton's views on space and time were only clearly brought out in the *General Scholium* of the second edition of 1713»[93]. Locke had perfect access to Newton's doctrine of absolute space and time when he wrote his review for *Bibliothèque Universelle et Historique*. In *Tempus et Locus* Newton wrote the following on the epistemological status of (absolute) time and space: «Time and Place in themselves do not fall under the senses, but are measured by means of sensible things, such as magnitudes of bodies, their positions, local motions, and any changes uniformly made»[94]. In similar vein, Newton noted:

Relative quantities, therefore are not the actual quantities whose names they bear but are those sensible measures of them (whether true or erroneous) that are commonly used instead of the quantities being measured. But if the meaning of words are to be defined by usage, then it is these sensible measures which should properly be understood by the terms "time," "space," "place," and "motion," and the manner of expression will be out of the ordinary and purely mathematical if the quantities being measured are understood here[95].

90. Newton, *The Principia,* cit., pp. 408-409 [emphasis added].

91. Andrew Janiak, *Newton's Philosophical Writings* (Cambridge University Press, Cambridge 2004), p. 26.

92. Cf.: «Thus instead of absolute places and motions we use relative ones, which is not inappropriate in ordinary human affairs, although in philosophy abstraction from the senses is required.» (*ibid.*, pp. 413-414).

93. Rogers, Locke's *Essay* and Newton's *Principia*, cit., pp. 217-232, p. 222. On the theology I agree.

94. James E. McGuire, *Newton on Place, Time and God: an unpublished source*, «British Journal for the History of Science» 1978 (11), pp. 114-129.

95. Newton, *The Principia*, cit., p. 414.

In the *scholium* on space and time, Newton further wrote that:

> Just as the order of parts of time is unchangeable, so, too, is the order of the parts of space. Let the parts of space move from their places, and they will move (so to speak) from themselves. For times and spaces are, as it were the places of themselves and of all things. All things are placed in time with reference to order of succession and in space with reference to order of position. *It is of the essence of spaces to be places, and for primary places to move is absurd* [cf. (iii)]. They are therefore absolute places, and it is only changes in positions from these places that are absolute motions[96].

It is significant in itself that Locke treats of God immediately after the sections on space and time (both infinite in quantity). God fills eternity and space. Locke notes that «God's infinite Duration, being accompanied with infinite Knowledge and infinite Power, he sees all things, past and to come»[97]. Locke noted:

> But if these Men are of the Mind, That they have clearer *Ideas* of infinite Duration, than of infinite Space, because it is past doubt, that GOD has existed from all Eternity, but there is no real Matter co-extended with infinite Space: Yet those Philosophers who are of the Opinion, That Infinite Space is possessed by GOD's infinite Omnipresence, as well as with infinite Duration by his eternal Existence, must be allowed to have as clear an *Idea* of infinite Space, as of infinite Duration; though neither of them, I think, has any positive Idea of Infinity in either case[98].

In the *Principia*, Newton also adhered to the view that God is omnipresent and eternally present:

> He is eternal and infinite, omnipotent and omniscient, that is he endures from eternity to eternity, and he is present from infinity to infinity; (…) He is not eternity or infinity but eternal and infinite; he is not duration and space, but he endures and is present. He endures always and is present everywhere, and by existing always and everywhere he constitutes duration and space. (…) God is one and the same God always and everywhere. He is omnipresent not only virtually but also substantially; for action requires substance[99].

Motion cannot be attributed to Him, not because he is immaterial, but because he is an *infinite* spirit[100]. In the *General Scholium* Newton later pointed out that «God experiences nothing from the motions of bodies; the bodies feel no resistance from God's *omnipresence*»[101]. Here Newton notes that God's being present at all times does not influence material bodies. In other words, God's being infinite in extension is not a (direct) cause of change in the physical world. That God is immaterial is irrelevant here: for Newton (and Locke)

96. *Ibid.*, p. 410 [emphasis added].
97. Locke, *Essay*, cit.,, II.xv, § 12, p. 204.
98. *Ibid.*, II.xviii, § 20, p. 222.
99. Newton, *The Principia*, cit., p. 941.
100. Locke, *Essay,* cit., II.xxiii, § 21, p. 307.
101. Newton, *The Principia*, cit., pp. 941-942 [emphasis added].

granted that immaterial active principles acted in *rerum natura*. In line with his empiricist epistemology, Locke adds that God's essence is unknown:

> For though his own Essence (which we certainly do not know, not knowing the real Essence of a Pebble, or a Fly, or of our own selves,) God be simple and uncompounded; yet I think I may say we have no other *Idea* of him, but a complex one of Existence, Knowledge, Power, Happiness, *etc*. infinite and eternal: which are all distinct *Ideas*, and some of them, being relative, are again compounded of other. […] [T]here is no *Idea* we attribute to God, bating Infinity, which is not also a part of our complex *Idea* of other Spirits[102].

Newton also rejected absolute characterisations of 'God'. We cannot, as Trinitarian orthodoxy would want it, define God's substance or essence[103], as Descartes attempted, by using predicates such as «eternal», «infinite», «omnipotent» or «omniscient» to characterize His essence[104]. We can only know God's attributes, not His substance. Let us compare Locke's statement with the *General Scholium*:

> As a blind man has no idea of colors, so we have no idea of the ways in which the most wise God senses and understands all things. He totally lacks any body or corporeal shape, and so he cannot be seen or heard or touched, nor ought he to be worshiped in the form of something corporeal. We have ideas of his attributes, but we certainly do not know what is the substance of any thing. We see only the shapes and colors of bodies, we hear only their sounds, we touch only their external surfaces, we smell only their odors, and we taste their flavors. But there is no direct sense and there are no indirect reflected actions [intimas substantias nullo senso, nulla actione reflexa cognoscimus] by which we know innermost substances; much less do we have an idea of the substance of God. We know him only by his properties and attributes and by the wisest and best construction of things and their final causes, and we admire him because of his perfections; but we venerate and worship him because of his dominion[105].

The most important overlaps are the following: Newton notes that we have no idea of the innermost substance of finite bodies; we only know the external surfaces of them and by extrapolation even less about the idea of an infinite God and that of God we only know his properties and attributes, but not his

102. Locke*, Essay,* cit., II.xxii, §§ 35-36, p. 315.

103. Newton, *The Principia*, cit., p. 942. Snobelen discusses several examples of compatible manuscript material (see Stephen D. Snobelen, *"God of Gods, and Lord of Lords:" the Theology of Isaac Newton's General Scholium to the* Principia*,* «Osiris» 2001 (16), pp. 169-208, pp. 180-186). For Descartes' idea of God, see Jean-Marie Beyssade, *The Idea of God and the Proofs of His Existence*, in: *The Cambridge Companion to Descartes*, John Cottingham (Ed.) (Cambridge University Press, Cambridge 1992), pp. 174-99.

104. On their anti-Trinitarianism, see Stephen D. Snobelen, *Isaac Newton, Socinianism and 'the one supreme God'*, in: *Socinianism and cultural exchange: the European dimension of Antitrinitarian and Arminian Networks, 1650-1720*, Martin Mulsow and Jan Rohls (Eds.) (Brill, Leiden 2005), pp. 241-293. Besides heretical views (which were in fact illegal at the time) Locke and Newton also shared alchemical secrets.

105. Newton, *The Principia*, cit., p. 942.

essence (an application of Locke's doctrine of essences to our nature of God)[106]. Note that Newton wrote "there is no direct sense [which agrees to what Locke called «extrinsical knowledge»] and there are no indirect reflected actions [which agrees to what Locke called «intrinsical knowledge»] by which we know innermost substances». There is other material that testifies of Locke's influence on Newton, for Newton used the terminology of Locke's differentiation between intuition and demonstrative knowledge. In manuscript material (CUL Add. Ms. 9597.2.11: f. 2^{r} and f. 3^{r}), composed roughly around the same time (1713-1715) as the General Scholium, Newton added several other points of criticism on Leibniz's Cartesianism (and Cartesian philosophy in general) than those which are commonly documented[107]. Mind that Newton's objections in this manuscript material against Leibniz and Cartesianism were not only physical or formulated from an «experimental philosophy» point of view, as is clear from published material[108]. Firstly, Newton rejected Descartes's innatism. Newton stressed that all our knowledge, including ideas, derives from phenomena. In the following passage we see Newton adopting an empiricist approach on sensory perception:

> What is taught in metaphysics, and if it is deduced from divine revelation, is religion[109]; if it is deduced from phenomena *by means of the five senses it pertains to physics*; *if it [is derived] from the knowledge of the internal actions of our mind by the faculty of reflection, it is philosophy concerning only the human mind and its ideas (as if internal phenomena) likewise pertains to physics*. To dispute about the objects of ideas, unless insofar as they are phenomena, is a dream. In all philosophy we have to start from the phenomena, and not admit any principles, causes or explanations of things, unless they are established by phenomena[110].

106. It is difficult to consider these as influences from Locke on Newton, as both in their earlier work independently endorsed an anti-essentialist stance with respect to God.

107. See Newton's *An Account of the Book Entitled Commercium Epistolicum* (1715) (reproduced in Janiak, *Philosophical Writings*, cit. pp. 123-127), his unpublished letter to the editor of *Mémoirs des Trévoux* (May 1712) (reproduced in *ibid*., pp. 114-117; Alan E. Shapiro, *Newton's "Experimental Philosophy"*, «Early Science and Medicine» 2004 (9), pp. 168-217, p. 201 [for the reconciliation of this date and his interpretation]), his letter to Cotes on 28 March 1713 (reproduced in Janiak, *Philosophical Writings*, cit., pp. 118-122) and, of course, the *General Scholium*.

108. The famous first line of the General Scholium is: "The hypothesis of vortices is beset with many problems." (Newton, *The Principia*, cit., p. 939).

109. In Keynes Ms. 6 (*Seven Statements on Religion*, post-1710): f. 1^{r}, Newton stated that religion and philosophy are to be «preserved distinct»: «We are not to introduce divine revelations into Philosophy, nor philosophical opinions into religion».

110. Author's translation of : «Quod in Metafysica docetur <& se a relevatione [missing word; probably "divina"] deducitur religio esse>, si a Phaenomenis per sensus quinque externos, ~~deducitur~~ a Physicā pertinet, ~~si a revelatione divina, religio <est>~~; si a cognitione actionum internarum mentis nostrae per sensum reflexionis, philosophia est de sola mente humana & ejus ideis <tanquam Phaenomenes internas> & ad Physicam <item> pertinet. De Idearum objectis disputare nisi quatenus sunt phaenomena ~~somniamus~~ <somnium est>. ~~Ideoque a Phaenomenis in omni Philosophia incipiendum est.~~ In omni Philosophia incipere debemus a Phaenomenis, & nullla admittere <rerum> principia nullas causas nullas expli-

Here Newton argued that since ideas can be considered as internal phenomena[111] they are part of physics, i.e. the study of phenomena. The distinction Newton made between (direct) perception by the senses and reflexion agrees to Locke's distinction between intrinsical and extrinsical knowledge. Newton had 13 works by Locke in his private library (including the *Essay*[112] and *De Intellectu humano*[113])[114]. We also know that Newton read parts of the *Essay* by May 1693[115]. In CUL Add. Ms. 9597.2.14, Newton synthesized his objections against Cartesian natural philosophy and metaphysics in a very strong way. Again Newton expressed his dissatisfaction with Descartes's doctrine of innate ideas:

> […] the author [Leibniz] hopes that the philosophy of Newton ([which] is founded on mathematical demonstrations from phenomena) is rejected and all at last unite in a philosophy which they will found on adapted hypotheses [to arrive] at geometrical [and] healthy metaphysical notions[116]. [This] metaphysics is based on innate ideas; the philosophy of Newton on phenomena through mathematical demonstrations. Innate ideas are hypotheses and does our author wish to found natural philosophy on phenomena and demonstrations [drawn] from metaphysical hypotheses[117];

cationes nisi quae per phaenomena stabiliuntur. Et quamvis tota philosophia non statim pateat, tamen satius est aliquid indies addiscere quam hypotheseωn praejudicijs mentes hominum præoccupare.» (CUL Add. Ms. 9597.2.11: f. 2[r]).

111. Newton interpreted the notion «phenomena» broadly as to include not only what can be known by the five senses but also «things internal which we contemplate in our minds by thinking» (McGuire, *Tradition and Innovation*, cit., p. 132. *Cf.* CUL Add. Ms. 3970: f. 621v (quoted in: Shapiro, *Newton's "Experimental Philosophy"*, cit., pp. 168-217, p. 198).

112. He had the 1690 edition of the *Essay* (F°, London).

113. He had the 1701 fourth edition of it (F°, London).

114. John Harrison, *The Library of Isaac Newton* (Cambridge University Press, Cambridge 1978), pp. 180-181 [books n° 966-978].

115. See Newton's famous letter to Locke, where Newton apologizes for accusing Locke of embroiling Newton «wth woeman» during his depressive breakdown. Newton notes: «For I am now satisfied that what you have done is just and I beg your pardon for my having hard thoughts of you for it & for representing that you struck at ye root of morality in a principle you laid down in your book of Ideas & designed to pursue in another book & that I took you for a Hobbist.» (Hall and Tilling (Eds.), *The Correspondence of Isaac Newton*, cit., vol. III, p. 280).

116. It was precisely the lack of proper (mathematical) demonstrations that led to the downfall of proper natural philosophy: «Defectu demonstrationibus haec philosophia intermissa fuit eandemque non inveni sed vi demonstrationum in lucem tantum revocare conatus sunt.» (CUL Add. Ms. 3965.9: f. 109[r]).

117. Author's translation of: «[…] sperat Author ut Philosophia Newtoni in Phaenomenis per Demonstrationes Mathematicas fundata rejiciatur & omnes tandem conveniant in Philosophia quam Geometrae in Hypothesibus ad notiones Metaphysicae sanae aptatis fundabunt. Metaphysica in ~~In Hypothesibus Idearum~~ Idaeis innatis, Philo<so>phia Newtoni in Phaenomenis <per mathematicis Demonstrationibus> fundatur. Idaeae innatae sunt hypotheses & vult author noster Philosophiam naturalem in ~~hypothesibus metaphysicis fundari. Et~~ phaenomenis ac demonstrationibis per hypotheses metaphysicas fundari; […]» (CUL Add. Ms. 9597.2.14: f. 4r).

Here Newton's rejection of Cartesianism was based on an empiricist epistemological criterion. As proper natural philosophy is based on experience alone, no room was left for the hypothesis of innate ideas (a thesis which is quintessential to Locke's epistemology). Given Newton's explicit phrasing and choice of terminology, it is highly likely that Newton's critique of Cartesianism and its innativism derive from Locke's epistemology.

4. Locke and the Limits of Corpuscularianism

In the first section of this essay, we have seen that Locke claimed that we have no idea of the primary qualities of bodies. He noted that we cannot know «the particular bulk, figure, and motion, of the greatest parts of the universe» is and that we «are ignorant of the several powers, efficacies, and ways of operation, whereby the effects which we daily see are produced». This is a first reason to doubt that Locke accepted the corpuscular theory as a realist theory: it was simply at odds with his epistemology in general and his account of real essences specifically. This was a constant in Locke's thought, which started in his studies in medicine (see *infra*) and was brought out systematically in his *Essay*. But: how to account for Locke's frequent reference to corpuscular theories?

This *prima facie* conundrum is resolved once we accept that *Locke's endorsement of corpuscularianism is merely methodological and pragmatic*. In his discussion of the nature of light and colours, Locke wrote as follows – note that this quote is rarely scrutinized by those wishing to render Locke a corpuscularian[118]:

> For supposing the Sensation or *Idea* we name *Whiteness* be produced in us by a certain number of Globules, which having a verticity about their own Centres, strike upon the *Retina* of the Eye, with a certain degree of Rotation, as well as progressive Swiftness; it will hence easily follow, that the more the superficial parts of any Body are so ordered, as to reflect the greater number of Globules of light, and to give them the proper Rotation, which is fit to produce this Sensation of White in us, the more White will the Body appear, that form an equal space sends to the *Retina* a greater number of such Corpuscles, with that peculiar sort of Motion. *I do not say that the nature of Light consists in very round Globules; nor of Whiteness in such a texture of parts as gives a certain Rotation to these Globules, when it reflects them; for I am not now treating physically of Light, or Colours*[119].

Locke was quite explicit here: he does not assert that the nature of light consists of small particles[120]. However, the corpuscular theory provides to hu-

118. Most notably: M. Mandelbaum, *Philosophy, Science, and Sense Perception: Historical and Critical Studies* (John Hopkins Press, Baltimore 1964). In fact, this quote is not discussed in any of the papers and books referred to in this essay.

119. Locke, *Essay*, cit., IV.ii, § 11, pp. 535-536 [emphasis added].

120. In the *Elements of Natural Philosophy* (1698) Locke notes: «The rays of light

mans an intelligible hypothesis about the nature of light, since it entails microscopic bodies analogous to the meso-level bodies that we are familiar with. The corpuscular theory of light was only an analogy. Locke was thus separating a hypothesis' intelligibility from its truth. In Chapter IV *Of the Names of Simple Ideas* of Book III *Of Words*, Locke:

> Those who tell us that *Light* is a great number of little Globules, striking briskly on the bottom of the Eye, speak *more intelligibly* than the Schools: but yet these words never so well understood, would make the *Idea*, the word *Light* stands for, no more to a Man that understands it not before, than if one should tell him; that *Light* was nothing but a Company of little Tennis-balls, which Fairies all day long struck with Rackets against some Men's Fore-heads, whilst they passed by others[121].

In line with these arguments, Edwin McCann has provided an important reading of the many corpuscular examples Locke provides in the *Essay*. McCann's words deserve to be quoted in full:

> They are intended rather to remind us that given our pretheoretical conception of causality of bodies, rough as this conception is, we find it most natural and plausible to think that the changes we observe in the sensible qualities of objects are rooted in changes in changes in their physical structure, as these changes in turn affect our sensory organs. Second, in line with this we should note that these examples appeal to nothing beyond our commonsense view of the world; in particular, they do not rely upon a prior acceptance of the corpuscularian hypothesis. On this view of Locke's arguments, the distinction between primary and secondary qualities is not based on the scientific correctness or at least the current scientific superiority (both alleged) of corpuscularianism, not is it backed only by a promissory note about the future development of science; it is instead a natural consequence of the ways we ordinary people think of the world, for better or worse. […] He aimed to show that the corpuscularian theory meshes very well with our commonsense views of things and that, in contrast, the Aristotelian theory, given its bizarre theory of causality and its indefensible distinction between sensible qualities that actually reside in the object ("real essences") and those which are merely imputed to it on the basis of the sensations they induce in us ("mere powers"), is one that we cannot finally make sense of[122].

Walmsley has recently corroborated this reading in his insightful analysis

themselves are not seen; but by them the bodies, from which they originally come; as the sun, or a fixt star; or the bodies, from which they are reflected; as a horse, or a tulip. When the moon shines, we do not see the rays which come from the sun to the moon, but by them we see the moon, from whence they are reflected.» (Woodfall *e.a.* (eds.), *The Works of John Locke*, cit., vol. IV, p. 594).

121. Locke, *Essay*, cit., III.iv, § 10, pp. 423-424 [emphasis added].

122. Edwin McCann, *Locke's Philosophy of Body*, in: *The Cambridge Companion to Locke*, Vere Chappell Ed.) (Cambridge University Press, Cambridge 1994), pp. 56-88, p. 66-67. *Cf.* his *Lockean Mechanisism*, in: *Locke*, Vere Chappell (Ed.) (Oxford University Press, Oxford 1998), pp. 242-260.

of Draft A.[123] Jacovides'[124], Peter R. Anstey's[125], and Lisa Dawning's[126] readings also fit very well with it. Jacovides notes that Locke accepted that we can explain phenomena by principles we cannot explain in turn[127]. Now, this is highly related to Newton's views for Newton's critics wanted full, mechanical causes. In CUL Add. Ms 9597.2, Newton thought the consequences of not accepting such 'partial' explanations through: this would imply – a view impossible for Newton to accept – that the only satisfactory explanations were 'causally complete', i.e. that they fully explain all causal agents occurring in between the observed phenomena and the ultimate cause:

> Otherwise, altogether no phenomenon could rightly be explained by its cause, unless the cause of this cause and the cause of the prior cause were to be exposed and so successively [and] continuously until the primary cause is arrived at[128].

Newton thought that such 'partial' explanations were perfectly legitimate, for he wrote:

> And to understand this without knowing the cause of gravity, is as good a progress in philosophy as to understand the frame of a clock & the dependence of y^{e} wheels upon one another without knowing the cause of the gravity of the weight which moves the machine is in the philosophy of clockwork, or the understanding the frame of the bones & muscles by the contracting or dilating of the muscles without knowing how the muscles are contracted or dilated by the power of y^{e} mind is [in] the philosophy of animal motion[129].

123. *Cf.*: «Locke's mechanism was not constitutive of his philosophical outlook, as some commentators have supposed. Locke had an independent project that was not subject to truth of any natural philosophical theory.» (Walmsley, *Locke's Natural Philosophy in Draft A of the Essay*, cit., p. 37).

124. *Cf.*: "[H]is only reason to believe in corpuscularianism is its explanatory force. Since corpuscularian explanations of phenomena necessarily appeal to impulse, and the explanation of impulse is mysterious, he cannot think that corpuscularianism is any more likely to be true than scholasticism, neo-Platonism, or magic.» (Jacovides, *The Epistemology under Locke's Corpuscularianism*, cit., 179).

125. Peter R. Anstey, *Locke on Method in Natural Philosophy*, in: *The Philosophy of John Locke: New Perspectives*, P.R. Anstey (Ed.) (Routledge, London 2003), pp. 26-42.

126. Lisa Downing, *The Status of Mechanism in Locke's* Essay, «The Philosophical Review» 1998 (107), pp. 381-414. Downing rightly notes that Locke considered corpuscularianism as a useful and psychologically plausible *hypothesis* (see also her: *The Uses of Mechanism: Corpuscularianism in Drafts A and B of Locke's* Essay", in: *Late Medieval and Early Modern Corpuscularian Matter Theory*, William Newman, John Murdoch, and Christoph Lüthy (Eds.) (Brill, Leiden and Boston 2001), pp. 515-534.) *Cf.* Ayers, *Locke*, cit., vol. II, p. 147 and Wilson, *Superadded Properties: The Limits of Mechanism in Locke*, cit., pp. 143-150.

127. Jacovides, *The Epistemology under Locke's Corpuscularianism*, cit., p. 180.

128. Author's translation of: «Alias nullum om[n]ino phaenomenon <per causam suam> recte explicari posset nisi causa <hujus> causae, & causa ~~priori~~ causae prioris redderetur & sic deinceps usque donec ad causam primam deventum sit.» (CUL Add. Ms. 9597.2.11: f. 3r).

129. Hall and Tilling (eds.), *The Correspondence of Isaac Newton*, cit., vol. V, p. 300.

Halabi, who strangely does not refer to McCann's paper "Locke's Philosophy of Body» in his paper, recently objected to such reading, on the basis of the following quote in the *Essay*:

I have in what just goes before, been engaged in Physical Enquiries a little further than, perhaps, I intended. But it being necessary to make the Nature of Sensation a little understood, and to make the *differences between the Qualities in Bodies*, *and the* Ideas *produced by them in the Mind*, to be distinctly conceived, without which it is impossible to discourse intelligibly of them; I hope, I shall be pardoned this little Excursion into Natural Philosophy[130];

Halabi concludes from this that corpuscularian philosophy is the «necessary background to his framework of ideas»[131] and that «a physical basis of corpuscles is set up as the background in which he sets up his epistemological framework»[132]. This is untenable as the remainder of the quote goes: «it being necessary in our present *Enquiry*, to distinguish the *primary* and *real Qualities* of Bodies, which are always in them, (*viz*. Solidity, Extension, Figure, Number, and Motion, or rest; and are *sometimes perceived by us, viz. when the Bodies they are in, are big enough singly to be discerned*), from those *secondary* and *imputed Qualities* […]»[133]. When particles are too little to be perceived they transcend our experience. Locke does not make any claims about the necessity of corpuscularianism, but rather about the necessity to distinguish primary from secondary properties. In order to defend his interpretation, Halabi further refers to yet another key-quote in the *Essay*:

Because the Active and Passive Powers of Bodies, and their ways of operating, consisting in a Texture and Motion of Parts, *which we cannot by any means come to discover*: […] I have here instanced in the corpuscularian Hypothesis, as that which is thought to go *farthest in an intelligible Explication of those Qualities of Bodies*; and I fear the Weakness of human Understanding is scarce able to substitute another, which will afford us a fuller and clearer discovery of the necessary Connexion and Co-existence, of the Powers, which are to be observed united in several sorts of them[134].

Again, he omits the rest of the text, which proceeds as follows:

This at last is certain, that, whichever Hypothesis to be clearest and truest, (*for of that it is not my business to determine,*) our Knowledge concerning corporeal Substances, will be very little advanced by any if them, till we are made to see, what Qualities and

130. Locke*, Essay*, cit., II.viii, § 22, p. 140.

131. Halabi, *A useful anachronism: John Locke, the corpuscular philosophy, and inference to the best explanation*, cit., p. 246.

132. *Ibid.*, p. 247. See also: John W. Yolton, *Locke and the Compass of Human Understanding* (Cambridge University Press, Cambridge 1970), pp. 46-49.

133. Locke*, Essay*, cit., II.viii, § 22, p. 140 [emphasis added]. See: Samuel C. Rickless, *Locke on Primary and Secondary Qualities*, «Pacific Philosophical Quarterly» 1997 (78), pp. 297-319 and Robert A. Wilson (2002), *Locke's Primary Qualities*, «Journal of the History of Philosophy» 2002 (40), pp. 201-228.

134. Locke*, Essay*, cit., IV.iii, § 16, pp. 545-546 [emphasis added].

Powers of Bodies have a *necessary Connexion or Repugnancy* one with another; which in the present State of Philosophy I think we know but to a very small degree: And *I doubt, whether with those Faculties we have, we shall ever be ably to carry out general Knowledge (I say not particular Experience) in this part much further*[135].

According to Locke, we cannot have knowledge about corporeal substances given our limited faculties of perception. Even in his younger years[136], Locke noted – in the context of Thomas Sydenham's therapeutics – that the small particles in *rerum natura* are so fundamentally insensible «that I thinke noe body will ever hope or defend even by the assistance of glasses or any other invention to come to a sight of them»[137]. This was a *basso continuo* in Locke's thought. As early as 1668, Locke expressed his scepticism about the human ability of knowing «the contrivances by which nature works» in his medical piece *Anatomie*[138]. He noted that «after all our porings and mangling the parts of animals we know nothing but the gross parts, see not the tools and contrivances by which nature works»[139]. In Draft A, Locke wrote: «But our senses faileing us in the discovery of those fine & insensible particles our understanding are unavoidably in the darke»[140]. In an entry in his notes, dated 8 February 1677 he writes:

> They [natural philosophers] might well spare them selves the trouble of lookeing any farther, they need not concerne or perplex them selves about the originall, frame or constitution of the universe, drawing this great machine into systems or their owne contrivance and building hypothesis obscure and perlexd and of noe other use but to raise disputes and continue wrangling[141].

In a letter on education to Edward Clarke in 1686, Locke noted:

> Natural philosophie as a speculative science I thinke we have none and perhaps may thinke I have reason to say we never shall. The works of nature are contrived by a wisdome and operate by ways too far surpasseing our facultys to discover or capacitys to conceive to be ever reduced into a science. […] But if he has a minde to lanch farther into general speculations I would recommend Des Cartes principles not as perfectly

135. *Ibid.*, IV.iii, § 16, p. 546 [emphasis added].

136. *Cf.* Downing, *The Uses of Mechanism: Corpuscularianism in Drafts A and B of Locke's Essay*, cit..

137. Public Office Record 30/24/47/2, f. 31r-v (quoted from Walmsley, *Locke's Natural Philosophy in Draft A of the Essay*, cit., p. 19). See especially: R.M. Yost, Jr., *Locke's Rejection about Sub-Microscopic Events*, «Journal of the History of Ideas» 1951 (12), pp. 111-130 and McCann, *Locke's Philosophy of Body*, cit., pp. 72-73. Downing has claimed that, according to Locke, microscopic events are impossible for practical reasons and not in principle (Lisa Downing, *Are Corpuscles Unobservable in Principle for Locke?*, «Journal of the History of Philosophy» 1992 (30), pp. 33-51).

138. Woolhouse, *Locke, A Biography*, cit., pp. 86-87.

139. Kenneth Dewhurst, *John Locke (1632-1704), Physician and Philosopher: A Medical Biography* (Wellcome Historical Medical Library, London 1963), p. 87.

140. Locke, *Draft A*, cit., p. 31; *cf.* Locke, *Draft B*, cit., p. 256.

141. Aaron and Gibb, *An Early Draft of Locke's Essay*, cit., p. 86, *cf.* pp. 99-103.

true or satisfactory to an inquisitive man <but> yet perhaps the most intelligible and most consistent with it self of any yet to be met with[142].

So Locke's statement that «[b]y the figure, bulk, texture, and motion, of these small and insensible corpuscles, all the phænomena of bodies *may* be explained»[143]. does not presuppose a realist commitment to corpuscularianism. It is an intelligible hypothesis for limited beings like ourselves, but it does not allow us to penetrate further into the realm of the primary qualities of things.

Newton's neutrality with respect to a corpuscular theory of light derived from his failure to deduce such theory from phenomena and his obsession with certainty[144]. Note that Newton explicitly held that both emission theories and wave theories of light were compatible with his definition of the rays of light[145]. Newton presupposed that light consists of discrete parts (*not* particles). That aspect is compatible with e.g. Hooke's wave theory. Ronald Laymon rightly claims that Newton's definition of a ray of light is not incompatible with diffusion theories, since Hooke allowed (as Hobbes did) the width of a ray to become smaller than any given magnitude to deal with refraction in curved surfaces[146]. In this case, the rays are independent of each other. In his first optical paper, Newton noted: «[b]ut, to determine more absolutely, what Light is, after what manner refracted, and by what modes or actions or produceth in our minds the Phantasms of Colours, is not so easie. And I shall not mingle conjectures with certainties»[147]. Locke, as an early member of the Royal Society, must have known Newton's paper and the controversy that followed it. In the study of the celestial and terrestrial bodies, the make-up of the affected entities (= the effects) is known. Newton knew that the effects which we want to explain are material bodies having mass moving along certain trajectories. Hence, we can apply the laws that pertain to these bodies. Newton was, however, unable to deduce from phenomena the corpuscularity of light. In optics Newton did not know the make-up of optical phenomena such as prismatic dispersion, because this would already presuppose an optical theory. Were

142. de Beer, *The Correspondence of John Locke*, cit., vol. II, Letter 844 (Locke to Edward Clarke, 29 January/8 February 1686), pp. 770-788, p. 785.

143. Woodfall *e.a.* (Eds.), *The Works of John Locke*, cit., vol. IV, p. 599 [emphasis added].

144. See Steffen Ducheyne, *On Optical and Mechanical Models: Newton's Failure to Construct a Satisfactory Theory of the Phenomena of Light and Colour*, «Logique et Analyse» 2006 (194), pp. 199-223 for the details. See also Alan E. Shapiro, *Fits, Passions, and Paroxysms, Physics, method, and chemistry and Newton's theories of colored bodies and fits of easy reflection* (Cambridge University Press, Cambridge 1993), esp. Chapter 1.

145. Hall and Tilling (Eds.), *The Correspondence of Isaac Newton*, cit., vol. I, p. 175.

146. Ronald Laymon, *Newton's* Experimentum Crucis *and the Logic of Idealization and Theory Refutation*, «Studies in History and Philosophy of Science» 1978 (9), pp. 51-77, p. 65. *Cf.* Alan E. Shapiro (1975), *Newton's Definition of a Light Ray and Diffusion Theories of Chromatic Dispersion*, «Isis» 1975 (66), pp. 194-210.

147. I. Bernard Cohen, *Isaac Newton's Papers & Letters On Natural Philosophy and related documents* (2nd edition) (Harvard University Press, Cambridge 1978 [1958]), p. 57.

they bodies? This would surely be an interesting claim from a theoretical perspective. If the rays of light possibly be globular, they would be attracted by material bodies; furthermore, if they had different masses, they would be subjected to different deviations. We would also be capable – as Newton attempted in Proposition 94, Book I of the *Principia* – to demonstrate that refraction is caused by a centripetal force tending downwards along the normal. Newton only succeeded in deriving the law of refraction conditionally, i.e. assuming some hypothetical forces which he could not derive «from phenomena»[148]. Newton disliked having to *postulate* a variety of unobservable motion and particles, without having rigidly deduced them from phenomena. Newton therefore always preferred to be silent on the nature of light and colours.

By contrast, in Locke's case, his neutrality with respect to a corpuscular theory of light derives from his pessimism on our knowledge of microscopic events. So while Locke was reluctant to accept the corpuscularity of light, as a matter of principle (we cannot know the structure of microscopic events); Newton did so, as a matter of fact (the corpuscular theory of light has not been deduced from phenomena in line with his rigid methodology).

5. Conclusion

If successful, in this essay I have established the following claims: (1) Newton's account of space and time influenced Locke significantly, (2) the tenets of Locke's empiricist epistemology were used by Newton in his criticism of Cartesianism, and, finally, (3) Locke and Newton differed in their motivations for not accepting the corpuscular theory of light. (1) and (2) debunk the myth that the flow of influence only went from Newton to Locke. (3) highlights that Locke was more of a sceptic than Newton. The interaction of Locke and Newton was one of mutual action and reaction, as often is the case when two great minds communicate.

148. Newton, *The Principia*, cit., p. 622.