

RESEARCH ARTICLE

Newton, the sensorium of God, and the cause of gravity

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Argument

It is argued that the sensorium of God was introduced into the *Quaestiones* added to the end of Newton's *Optice* (1706) as a way of answering objections that Newton had failed to provide a causal account of gravity in the *Principia*. The discussion of God's sensorium indicated that gravity must be caused by God's will. Newton did not leave it there, however, but went on to show how God's will created active principles as secondary causes of gravity. There was nothing unusual in assuming that God, acting as the First Cause, operated in nature by means of secondary causes; but it was unusual to devote as much time to discussing God's precise role as to discussing the secondary causes themselves. It is contended that Newton felt the need to do this to persuade readers that what might seem like a second cause that could not possibly work could be made to work by the omnipotent God.

Keywords: active principles; causation; God; gravity; Isaac Newton; sensorium; space; the will

In his published works, Newton makes two brief mentions of what he calls the sensorium, or sensory, of God.¹ God's sensorium first appeared in two of the *Quaestiones*, which Newton added to the Latin translation of the *Opticks*, the *Optice* of 1706, and it first appeared in English in the 1717 edition of the *Opticks*. In Query 28 of the 1717 edition, after a brief discussion of the "Sensory of Animals," Newton makes a bold analogy:

And these things being rightly dispatch'd, does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and thoroughly perceives them, and comprehends them wholly by their immediate presence to himself. (Newton [1717] 1979, 370)²

The focus here is on the role of the Sensory in *perception*. Later, in Query 31, Newton focuses on what he sees as the other role of the Sensory, the *will*. So, having insisted that God's choice must account for the various symmetries of the bodies of animals, Newton concludes:

[These symmetries] can be the effect of nothing [else than the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies. (Ibid., 403)³

¹For a complete survey of all the places where Newton discusses the concept of a sensorium, see Kassler 2018, 3–27. The only two of these that are concerned specifically with God's sensorium are the two discussed here.

²The original Latin appeared in *Quaestio* 20, of Newton 1706, 307–15, at 315: "Atque his quidem rite expeditis, Annon ex phaenomenis constat, esse Entem Incorporeum, Viventem, Intelligentem, Omnipraesentem, qui in Spatio infinito, tanquam Sensorio suo, res Ipsas intime cernat, penitusque perspiciat, totasque intra se, praesens praesentes complectatur . . ."

³Newton 1706, 346: "horum sane omnium conformatio prima, nulli rei tribui potest, nisi Intelligentiae & Sapientiae Entis Potentis semperque, Viventis; quod sit ubique scilicet praesens, possitque Voluntate sua corpora omnia in infinito suo Sensorio movere, adoque cunctas Mundi universi partes ad arbitrium suum fingere & refingere, multo magis quam

It is the contention of this paper that Newton introduced his brief speculations about the sensorium of God into the *Opticks* as a way of answering objections from Continental philosophers that he had failed to provide a *causal* account of gravity.⁴ Newton did not introduce the two brief mentions of God's sensorium merely in order to reveal to his readers his beliefs about the relationship between God and his Creation (but on this, see Connolly 2014, and Henry and McGuire 2018). Although these comments do indicate Newton's views on Providence, he introduced them into the Queries with a natural philosophical purpose. His specific aim, I wish to suggest, was to defend his belief that gravity was an immaterial force operating between bodies that were set at a distance from one another. Believing that gravitational attraction "arises from some cause that penetrates as far as the centers of the sun and the planets without any diminution of its power to act," and so could not be a mechanical cause (because mechanical causes can only operate on the *surfaces* of bodies) (Newton [1687/1713] 1999, 943), Newton was always seeking ways to explain how this might be. Brief and elliptical as these comments on the sensorium of God were, they were nonetheless extremely important for Newton. Commenting on the introduction of God's sensorium into the *Optice*, R. S. Westfall wrote:

In the Latin edition of the *Opticks*, he gave the fullest exposition of his own conception of nature he would ever put in print before, in his old age, he tried to placate critics by seeming retreats to more conventional positions. (Westfall 1980, 648)

It is not clear what "retreats" Westfall had in mind, but certainly Newton never retreated from his claims about the sensorium of God. Rather, he simply did not develop these ideas in any subsequent writings. In spite of this, and in spite of their brevity, they played an undeniably important role in his natural philosophy.

The sensorium: Animal, human and divine

The sensory, or sensorium, sometimes called the common-sense, was held to be a place in the brain to where the five external senses delivered their information. The soul, or mind, was held to be also there in the sensorium and was therefore able to perceive this information by virtue of being directly present to the incoming sensory data. Clearly, it would be absurd to suppose the soul needed its own eyes and ears to see and hear messages coming in from the external eyes and ears. Accordingly, it was assumed that the information simply had to be presented immediately to the soul, and somehow (though just how remained mysterious) the soul could perceive and comprehend the information. Newton summed it up perfectly well immediately before he first introduced God's sensorium in *Quaestio* 20. In English in the 1717 Query 28, he put it this way:

Is not the Sensory of Animals that place to which the sensitive Substance is present, and into which the sensible Species of Things are carried through the Nerves and brain, that there they may be perceived by their immediate presence to that Substance? (Newton [1717] 1979, 370)

This is not an idea that Newton invented to suit his own purposes. He was simply adapting a standard belief. It was generally accepted that the sense organs merely conveyed information

Anima nostra . . ." It should be clear to Latinate readers, from this and the foregoing note, that the Latin is a close translation of Newton's English, and I will not provide the Latin from now on.

⁴Newton arrived at his universal principle of gravitation by deriving it mathematically from Kepler's laws of planetary motion and the assumption of an attractive force which varied inversely with the square of the distance between the planets—starting points which were suggested by Robert Hooke. I do not discuss this aspect of his theory of gravity here, but literature is vast. See, for example, Nauenberg 2006; Nauenberg 2019; and Belkind 2012. Since it was derived mathematically the theory was not furnished with a *causal* explanation of gravity. The cause of gravity had to be inferred subsequently, according to Newton, by using empirical phenomena to "deduce Causes from Effects" (Newton [1717] 1979, 369).

to the soul, or the mind, and it was really the soul/mind that perceived what the senses were communicating to it (Henry and McGuire 2018, 589–91). We can see this, for example, in John Locke's *Essay Concerning Human Understanding*:

This is certain: that whatever alterations are made in the body, if they reach not the mind; whatever impressions are made on the outward parts, if they are not taken notice of within, there is no perception. Fire may burn our bodies with no other effect than it does a billet, unless the motion be continued to the brain, and there the sense of heat, or idea of pain, be produced in the mind; wherein consists *actual perception*. (Locke 1690, II. 9. 3)

So, although Newton talks of God seeing and thoroughly perceiving things, he is not thereby committed to the view that God has sense organs. For Newton, just as the soul can directly perceive things within the sensorium, so God can perceive things within his sensorium. And, since infinite space is “as it were . . . his sensory,” and everything is in infinite space, then everything is in God's sensorium, or “immediately present” to his sensorium. Newton actually added to Query 31 in 1717 a comment that was not present in the Latin *Optice*:

The Organs of Sense are not for enabling the Soul to perceive the Species of Things in its Sensorium, but only for conveying them thither; and God has no need of such Organs, he being everywhere present to the Things themselves. (Newton [1717] 1979, 403)⁵

God perceives things “by their immediate presence to himself” (ibid., 370).

Perception was clearly regarded as an important function of the soul, or mind, but it was not the only one. An equally important feature of the mind was the will. Perception and will were regarded at the time as the two main functions of the mind; once again, Locke's *Essay* illustrates the point:

The two great and principal Actions of the Mind, which are most frequently considered, and which are so frequent, that everyone that pleases, may take notice of in himself, are these two: Perception, or Thinking; and Volition, or Willing. (Locke 1690, II. 6. 2)

Newton evidently recognized these dual purposes and wanted to show that the analogy between animal, or human, sensories and the sensory of God could hold for both perception and willing. The first appearance of God's sensorium, in *Quaestio* 20, discusses perception and comprehension, while the second, in *Quaestio* 23, focuses on God's will. Although Newton himself does not use the word “mind,” preferring “sensitive Substance” (*Substantia sentiens*) in *Quaestio* 20, Samuel Clarke, in his exchange with Leibniz, suggests that for Newton the sensorium was “the place where the mind resides” (Clarke's Third Reply, §10, in Alexander 1956, 33).

Now, Newton scholars have paid very little attention to these comments.⁶ After all, they are brief, and seem to be mentioned in passing, with no build-up, and having mentioned them Newton quickly moves on to other topics. So, it has been easy for scholars to dismiss them as minor or even insignificant aspects of Newton's thought. The only major study of these comments until very recently was itself focused on an aspect of these comments that seemed to confirm that Newton only meant them as nothing more than an intriguing metaphor. This was the article

⁵Presumably, Newton added the passage in which this comment appears (which is concerned to deny any suggestion that God has a body) because of his awareness that Leibniz insisted that if Newton believed God had a sensorium then he must believe that God has a body. See, for example, “Mr. Leibniz's Second Paper, § 3”, in Alexander 1956, 16–17. See also, Connolly 2014, 192–94.

⁶Although this present paper is now following upon the publication of two very recent major studies: Connolly 2014; and Henry and McGuire 2018. There has also recently appeared a broader study of all of Newton's discussions of the sensorium, animal, human, and divine: Kassler 2018.

published in 1961 By Alexandre Koyré and I. B. Cohen, entitled “The Case of the Missing *Tanquam*” (Koyré and Cohen 1961). Koyré and Cohen wanted to get to the bottom of the disagreement about the status of the sensorium between Newton’s great rival G. W. Leibniz, and Newton’s defender Samuel Clarke. In his famous exchange with Clarke, Leibniz wrote:

I find in express words, in the Appendix to Sir Isaac Newton’s *Opticks*, that space is the *sensorium* of God. (Leibniz’s Second Paper, §3, in Alexander 1956, 16)

To which, Clarke replied:

Sir Isaac Newton does not say, that space is the sensory; but that it is, by way of similitude only, *as it were the sensory, etc.* (Clarke’s Second Reply, §3, in Alexander 1956, 21)

Koyré and Cohen argued, on material grounds, that both might have been right. When Newton added the *Quaestiones* with these comments to the Latin *Optice* in 1706, he referred in *Quaestio* 20 to God “who in infinite space, his sensory, sees the things themselves . . .” Evidently Newton quickly realized he had made a theological error and revised this sentence simply by adding the Latin word “*tanquam*”, which can mean “as if,” or “so to speak,” or similar qualifications. So, the comment now read, as Clarke suggested, “who in infinite space, *as it were* his sensory . . .” (*qui in Spatio infinito, tanquam Sensorio suo . . .*) (Newton 1706, 315; Newton [1717] 1979, 370). Unfortunately for Newton, the relevant set of pages had already been printed by the time he sent the printers this correction, and so a new page had to be printed and stuck over the original in each set of pages. Clearly, it was an expensive and time-consuming mistake to put right.

Furthermore, Koyré and Cohen were able to establish that the printer had already sent out some copies of the book before Newton asked for the correction to be made. Always eager to read whatever Newton published, Leibniz bought one of the first copies to emerge from the printer, and so his copy was an uncorrected copy (at least this is what Koyré and Cohen surmise). If that was the case, then Leibniz was perfectly correct to say that he had read Newton saying space is the sensorium of God, “in express words.”⁷

Newton’s determination to insert the “*tanquam*,” and Clarke’s insistence that Newton’s comment was “by way of similitude only,” seems to have been taken by scholars to indicate that Newton was not saying anything with any real significance. Accordingly, little more needed to be said about God’s sensorium.⁸ In so far as it *has* appeared in scholarly discussion it is usually in connection with attempts to understand Newton’s views on the relationship between God and absolute space, and God’s sensorium is relegated to a merely incidental role (e.g. Koyré 1957, 235–72; Ray 1991; Gorham 2011b).

Equally, however, Newton’s determination to immediately correct his first comment on God’s sensorium can be taken as an indication of its importance to him. It seems clear that, even after the addition of the *tanquam* to *Quaestio* 20, Newton still believed that infinite space and the world that occupied it were closely related in some way to the mind of God. As Patrick Connolly has recently shown, the most important aspect of Newton’s thinking about the sensorium was that he held it to be the place where an animal, or human, and by extension any thinking being, exercised their will. The sensorium of God, consequently, was the place where God exercised his will

⁷Although Koyré’s and Cohen’s suggestion was based on impressive scholarship, it is equally possible that Leibniz’s comment was based on his reading of *Quaestio* 23 of the *Optice*, where there is no qualification to tone down the claim that the Universe exists in God’s “boundless uniform Sensorium.” So, Leibniz may have owned a corrected copy of the *Opticks* and might still have believed that Newton plainly said space was the sensorium of God. See Newton 1706, 346, or Newton 1979, 403; and Leibniz’s Fifth Paper, § 78, in Alexander 1956, 81. For fuller discussion of this point, see Priestley 1970, 37–38; and Connolly 2014, 194–95.

⁸The only specific consideration of God’s sensorium published after this (until very recently) did not consider its role in Newton’s philosophy, but focused on Leibniz’s views: (Bernstein 1977).

(Connolly 2014). The question remains, however, as to just why Newton introduced the sensorium of God into these two queries. Why did Newton need to invoke the will of God in just the way he did at these two separated points in the Queries?

The sensorium of God and theology

Although Newton immediately changed his initial suggestion that infinite space *was* God's sensorium, to the weaker suggestion that it was merely similar to God's sensorium; he made no changes to the second suggestion that God could move the bodies in the universe, that is in "his boundless uniform Sensorium" by an act of will. Bearing in mind that the correction to the first comment was costly and complicated, it seems that Newton must have had a serious reason for changing it. And yet, he saw no need to change the second comment about the sensorium of God. So, what was it that Newton felt was wrong about the first comment that it could not be allowed to pass into the hands of the reading public?

So far, the only attempt to provide an answer to this question has been provided by Patrick Connolly, author of the first study devoted to Newton's speculations concerning God's sensorium. Connolly has suggested that there was a theological problem with the first statement, but the second statement was perfectly compatible with sound theology as Newton understood it. Accordingly, the first had to be corrected, but the second did not (Connolly 2014, 194–96).

The problem, according to Connolly, is that the first statement presents God as a perceiver. Perceivers are passive, however, and can be changed by what they perceive (they might learn something, for example). In traditional theology, of whatever creed, God was always held to be supremely and purely active, and to consider him to be merely passive in any respect was to diminish his perpetually active agency in the world. Furthermore, God was always held to be completely immutable or unchangeable. Two considerations led to this assumption: firstly, God was held to be perfect, but changeability suggests a lack of perfection, a need to still seek perfection; secondly, there was no cause that could conceivably initiate change in the omnipotent and omniscient God.

Newton's religion was unorthodox, but even he would never have deliberately denied the purely active nature of God, or that God was immutable. So, Newton recognized his mistake and took steps to correct it. He perhaps felt that the main thrust of what he was saying in the whole passage was clear enough, and theologically acceptable—namely, that the omnipresent God *comprehends* all things "wholly by their immediate presence to himself." Now comprehending is an active enterprise, and to attribute comprehending to God is perfectly legitimate theologically. But Newton made the mistake of rhetorically building up to the comprehension of God—God sees all things, he perceives all things, he comprehends all things. *Seeing* was clearly meant metaphorically, *perceiving* was meant to imply a more thorough awareness of things than just seeing them, but should also be understood metaphorically, but what God really does, literally, is to fully comprehend all things, to fully understand them as the creator of them. So, although Newton perhaps felt that his main point, about God's comprehension, was perfectly acceptable and could be taken literally, he realized that he needed to inform his readers that he only intended God's seeing and perceiving metaphorically—hence the "tanquam". Or so Connolly claims (*ibid.*, 195).

It ought to be clear from this that Newton made no mistake when he wrote the second comment about the sensorium of God in Query 31. Here God is presented as supremely active, moving the bodies in infinite space by his will, and even forming and reforming the parts of the universe. Newton felt no need, therefore, to make any changes to this part of his text (*ibid.*, 195–96). This is a good story, well told by Connolly, but in the end it remains unconvincing. The *tanquam* clearly qualifies the claim that infinite space is God's sensorium. If Connolly were right it ought to qualify "sees the things themselves"—God, as it were, sees the things themselves.

There is a much simpler explanation for the single added *tanquam*. It seems reasonable to suppose that Newton did not want to commit himself to the view that infinite space was quite literally the sensorium of God, so that God's sensorium was nothing more or less than infinite space. Similarly, he did not want to suggest that God had a sensorium in precisely the same way that animals and humans were said to have a sensorium (for example, he would not want his readers to assume that God's sensorium was a place in God's brain). In the General Scholium added to the second edition of the *Principia* (1713), Newton noted that "all discourse about God is derived through a certain similitude from things human, which while not perfect is nevertheless a similitude of some kind" (Newton [1687/1713] 1999, 942–43). Presumably Newton felt that to understand God's will, it helped to think of a sensorium from where it was enacted; but this only helped us to understand, and could not be said to be literally true. Accordingly, when he reconsidered *Quaestio* 20 he realized that he must add the *tanquam* (see also Kassler 2018, 112). Certainly, in several manuscript drafts of a 1716 letter to Conti Newton rejects a perfectly literal interpretation of these passages. For example, in one draft he writes of Leibniz that "He accuses me as if I said that God had a Sensorium in a littleral sense." And in another he writes "as if any man except the Anthropomorphites ever feigned that God had a Sensorium in a littleral sence" (Koyré and Cohen 1962, 109, 114).

There remains a problem with this account, however. If Newton's concern was to avoid suggestions that God had a sensorium in a literal sense, then he should have also qualified the second mention of God's sensorium. In this second mention he says that all the bodies of the universe are "within his boundless uniform Sensorium." Surely, this calls for another *tanquam*? Unless Newton felt that, having made it clear thirty pages earlier that he was speaking merely of a similitude, he did not need to repeat the point (especially, because making a second correction to the already printed text would cause even more difficulty and expense). Accordingly, it seems fairly safe to assume that Newton felt he shouldn't commit himself to a literal identification of infinite space with the sensorium of God, and so added the *tanquam*, the first time he wrote of it. He avoided the extra expense and inconvenience of correcting the second comment, simply by allowing the *tanquam* in *Quaestio* 20 to stand as a qualifier of both mentions of God's sensorium. Certainly, if anyone objected to the comment in *Quaestio* 23, he could simply refer them back to the earlier comment, where he had already made it clear (he could legitimately claim) that he was speaking metaphorically. Newton had ample opportunities to adjust these comments for the 1717 edition, but he evidently did not feel the need to make any further changes.

Before moving on, it is perhaps worth noting that Leibniz did lay other charges against Newton's talk of the sensorium of God. Evidently, Newton never accepted these as valid criticisms of his stance, and left it to Samuel Clarke in his famous published correspondence with Leibniz to defend his position. One of these charges was that if God was considered to have a sensorium then he must be a material being. Leibniz wrote to Clarke that "the word sensorium hath always signified the organ of sensation" (Leibniz's Second Paper, § 3, in Alexander 1956, 16–17), and seems to have regarded it as a physical part of the brain. Clarke responded that "The word sensory does not properly signify the *organ*, but the *place* of sensation" (Clarke's Second Reply, § 3, in Alexander 1956, 21). The implication seems to be that although sensation takes place in the head, it is not associated with a bodily organ. Clarke had already tried to impress upon Leibniz that Newton's point depended upon the immaterial *mind*:

Sir Isaac Newton doth not say, that space is the organ which God makes use of to perceive things by . . . but on the contrary, that he, being omnipresent, perceives all things by his immediate presence to them, in all space wherever they are, without the intervention or assistance of any organ . . . In order to make this more intelligible, he illustrates it by a similitude: that as the *mind* of man, by its immediate presence to the pictures or images of things, form'd in the brain by the means of the organs of sensation, sees those pictures as if they were the things themselves; so God sees all things, by his immediate presence to them; he being

actually present to the things themselves, to all things in the universe; as the *mind* of man is present to all the pictures of things formed in his brain. Sir Isaac Newton considers the brain and organs of sensation as the means by which those pictures are formed: but not as the means by which the *mind* sees or perceives these pictures, when they are so formed. (Clarke's First Reply, §3, in Alexander 1956, 12–13)

Instead of simply pointing to the *tanquam* and the metaphorical nature of Newton's talk of God's sensorium, Clarke tries to shift the focus from the sensorium itself to the immaterial mind, or soul, that is located there. This also serves to repel Leibniz's objection that if God is said to have a sensorium, then he is said to have parts. God, as the supreme exemplar of what Descartes designated *res cogitans*, might be said to be all mind, and even if that mind is located, *as it were* in God's sensorium, then that mind can still be one, simple, and indivisible (Connolly 2014, 192–94).

Certainly, Newton himself was quick to deny any suggestions that talk of the sensorium of God implies God has organs or parts:

[God] is more able by his Will to move the Bodies within his Boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies. And yet we are not to consider the World as the body of God, or the several Parts thereof, as the Parts of God. He is an uniform Being, void of Organs, Members or Parts, and they are his Creatures subordinate to him, and subservient to his Will . . . (Newton [1717] 1979, 403)

In view of the fact that Newton, and Clarke, defended the suggestion that the world and all it contains existed “within his [God's] boundless uniform Sensorium,” it seems clear that it was a suggestion that Newton felt captured something important about the nature of God, the world, and the relationship between them. The two mentions of the sensorium of God in the Queries, although very brief and seemingly included in almost a throw-away fashion, were evidently more important than might appear from a superficial reading. Although it is impossible to say to what extent Newton saw infinite space as somehow representing the sensorium of God, he seems to have felt that this “similitude” provided a valuable insight into the relationship between God and his Creation (see Kassler 2018, 104–25; and Henry and McGuire 2018).

The importance of this similitude is especially marked if we remember that Newton was by no means given to flights of fancy. In spite of his well known rejection of hypotheses in the General Scholium which he added to the second edition of the *Principia* in 1713, Newton did allow hypotheses if they seemed to him to be indicated and supported by empirical results. What he objected to in the General Scholium, and earlier, were hypotheses of the kind invoked by Descartes to explain gravity and the motions of the planets. “The hypothesis of vortices,” he wrote, “is beset with many difficulties” (Newton [1687/1713] 1999, 939). Not only was there no direct evidence in its favor, but empirical evidence and mathematical analysis strongly suggested it was completely misconceived.

Elsewhere, however, Newton did offer his own hypotheses as tentative explanations for phenomena, but only when he could point to some empirical evidence in support of the putative explanation. Clearly, Newton felt that his hypothesis of the sensorium of God, and its concomitant account of God's action in the world, were based on experiential evidence. As Newton wrote in *Quaestio* 20, “does it not appear from Phaenomena . . .”; and in *Quaestio* 23 he used the argument from design to insist that the “Contrivance” of the parts and instincts of animals “can be the effect of nothing else than the Wisdom and Skill of a powerful ever-living Agent,” and that furthermore, such an agent must be “more able by his Will to move the Bodies within his boundless uniform Sensorium . . . than we are by our Will to move the Parts of our own Bodies” (Newton [1717]

1979, 370, 403).⁹ In the second edition of the *Principia*, Newton made the more general point that “to treat of God *from phenomena* is certainly a part of experimental philosophy” (Newton [1687/1713] 1999, 943; my emphasis).

As we shall see in the next section, the essential point of the idea that infinite space was comparable to something we might choose to call the sensorium of God, in so far as it is the place in which God exercises his will, was that God could create the world and everything in it merely by willing it into existence, just as we can move the parts of our bodies just by willing it. And if God could create the world, he could also move all of its bodies “within his boundless uniform Sensorium.”

The sensorium of God and the cause of gravity

To invoke the sensorium of God the way Newton does seems to be uniquely original. I know of no comparable discussion in the writings of any other natural philosopher, or natural theologian, much less in those of any religious author. We need to ask ourselves, therefore, what led Newton to this highly original way of thinking about God and his action in the world? Unfortunately, there seems to be no external evidence that we can bring to bear in helping us to answer this question. Newton does not discuss the concept of God’s sensorium in his correspondence, and if he discussed it with Samuel Clarke when he was defending Newton’s view in the correspondence with Leibniz, it must have been conducted orally by these two neighbors, and nothing was written down (Meli 2016, 590–92). Jamie Kassler has recently surveyed everything that Newton has to say about sensories—in animals and humans, as well as these two references to God’s sensory—but nothing in Newton’s discussions of animal and human sensories helps us to understand why Newton developed the idea of a corresponding sensorium of God (Kassler 2018).¹⁰ Accordingly, we must proceed by a close reading of the two comments themselves, and their immediate context in the Queries.

So, let us begin by looking at the context when God’s sensorium was first introduced. I will refer to the English translations in the 1717 edition, and use the numbering of the relevant Queries in that edition (28 and 31—but in 1706 these were 20 and 23). Query 28 begins with a long, critical, and ultimately dismissive account of all attempts to explain physical phenomena by supposing the existence of an aether. It begins by rejecting aetherist accounts of light, but soon moves on to dismissing Descartes’s and others’ theories about the motion of planets through heavens filled with “fluid Mediums” (Newton [1717] 1979, 362–68).

At this point Newton turns to what he considers to be the correct account of gravity and the motions of the planets:

And for rejecting such a Medium, we have the authority of those the oldest and most celebrated Philosophers of Greece and Phoenicia, who made a Vacuum, and Atoms, and the Gravity of Atoms, the first Principles of their Philosophy; tacitly attributing Gravity to some other Cause than Dense Matter. (Ibid., 369)

Newton goes on to say that this correct view was dismissed by later philosophers, “feigning Hypotheses for explaining all things mechanically.” So, Newton has now led himself into a discussion of gravity and its cause. He knows that the cause of gravity is non-mechanical, because he

⁹Implicit in this, of course, is that it is part of our own undeniable experience that we can move our bodies by our will—we shall return to this below. For a fuller account of Newton’s attitude to hypotheses, see Cohen 1966, and Shapiro 2004.

¹⁰With regard to the divine sensorium, Kassler seems to miss its significance as the place where God exercises his will, and focuses instead on trying to understand Newton’s suggestion that it could be identified with infinite space (Kassler 2018, 104–25). Furthermore, she declares that it is outside the scope of her investigation to investigate “the motives that prompted Newton to investigate, as well as formulate his *sensorium* concept as a theoretical construct” (ibid., 138).

established this in the *Principia*,¹¹ but he does not have a ready answer as to what is the cause of gravity. So, at this point he brings God into the discussion:

The main Business of natural Philosophy is to argue from Phaenomena without feigning Hypotheses, and to deduce Causes from Effects, till we come to the very first Cause, which certainly is not mechanical (Newton [1717] 1979, 369).

At this point Newton introduces the argument from design to reinforce the existence of an intelligent first cause; “whence arises all that Order and beauty which we see in the World?” (ibid.) Among the various questions he lists which he believes can only be resolved by acknowledging a first cause is: “whence is it that the Sun and Planets gravitate towards one another, without dense Matter between them?” Still pursuing aspects of design in the world, he soon comes to animals:

How came the Bodies of Animals to be contrived with so much Art, and for what ends were their several Parts?

This brings Newton to mention the will, and immediately after, the sensory of animals:

How do the Motions of the Body follow from the Will, and whence is the Instinct in Animals? Is not the Sensory of Animals that place to which the sensitive Substance is present . . . ? (Ibid., 369–70)

It is at this point that Newton makes the first of the two statements about the sensorium of God. Let us look at it again:

And these things being rightly dispatch’d, does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and thoroughly perceives them, and comprehends them wholly by their immediate presence to himself . . . (Ibid., 370)

Now, there is a non sequitur here. Given the immediately preceding discussion, about the order and design in the heavens and in animals, we might expect Newton to say what appears from phenomena is that there is an all powerful designer God. That would, at least, have followed, but he does not really make that point at all. Instead he is seemingly side-tracked into saying that God, like animals and humans, has a sensory, and his sensory is somehow related to infinite space. Newton has brought infinite space into the discussion out of the blue.

What are we to make of this? It seems to me that we can only suppose that it made sense to Newton because he had already been dwelling on these matters for many years. It looks very much as though Newton is trying to give an abbreviated account of complex matters he has thought long and hard about, but has left out crucial connecting steps, and the result doesn’t really make sense to naïve readers.¹² Perhaps Leibniz might have pointed out this non sequitur, if he had not been preoccupied by what he saw as the more dangerously materialist implications of Newton’s claims about the sensorium of God.

Be that as it may, we can trace out the salient points in the argument: Newton is concerned to explain gravity without introducing mechanical hypotheses; he thinks about God, the first cause, who is not mechanical; he then turns to the design argument as a way of reaffirming the existence

¹¹He explicitly rejected mechanical accounts of gravity in the General Scholium, added to the second edition of the *Principia* in 1713 (see Newton 1999, 943), but it is clearly implicit throughout the first edition of 1687.

¹²Matters are not clarified in the various draft versions Newton wrote, which can now be consulted at the online Newton Project: <http://www.newtonproject.ox.ac.uk/view/texts/normalized/NATP00055>. (last accessed, September 1, 2020).

of God, this leads him to wonder how animals and humans move their bodies merely by their will; and then he introduces the sensorium of God, which he likens to infinite space. Interestingly, and surely significantly, there is a very similar pattern of discussion in the second place where the sensorium of God is mentioned, as we shall now see.

Query 31 is the longest and richest of the Queries and starts off by reiterating Newton's belief that all physical phenomena can be explained by assuming bodies are made of invisibly small particles which are endowed with attractive and repulsive forces "by which they act at a distance" (Newton 1979, 375–76). What follows are various examples, chemical and physical, which Newton believes confirm his claim; "For we must learn from the Phaenomena of Nature", he writes, "what Bodies attract one another, and what are the Laws and Properties of the Attraction . . ." (Ibid., 376).

Crucially, he brings this survey to an end by introducing Gravity into the *Opticks* for the second time:

And thus Nature will be very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attractive and repelling Powers which intercede the Particles. (Ibid., 397)

Shortly after, God is brought in as the Creator of these particles and their properties, and after a short digression rejecting charges that he is resorting to occult qualities, Newton returns, for the first time since Query 28, to the argument from design to bring God once again into the proceedings.

Now by the help of these Principles, all material Things seem to have been composed of the hard and solid Particles above-mention'd, variously associated in the first creation by the Counsel of an intelligent Agent. For it became him who created them to set them in order. (Ibid., 402)

As in Query 28, Newton quickly introduces animals into the discussion, and allows that to lead straight into his second claim about the sensorium of God:

Also the first Contrivance of those very artificial Parts of Animals, the Eyes, Ears, Brain . . . and other Organs of Sense and Motion; and the Instinct of Brutes and Insects, can be the effect of nothing else than the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies. (Ibid., 403)

It should be noted that there is no explicit mention of infinite space here. We can easily imagine contemporary readers asking themselves what are these Bodies within God's sensorium? It is only if they remember Newton had already mentioned that infinite space is (as it were) God's sensorium, that they might realize that Newton must be referring here to all the Bodies in the universe, which are now said to exist in God's boundless sensorium. Presumably, therefore, infinite space in which all the bodies in the universe are normally held to exist, *is* God's boundless sensorium, or is very much like it.

It can be seen, anyway, that in both places where the sensorium of God is mentioned, it follows on from a discussion of the cause of gravity. And in both places there is a clear sequence of discussion: the cause of gravity is introduced, Newton then uses the argument from design to affirm

the existence of God, and then the sensorium of God is mentioned and linked to infinite space and the Universe. In order to make the transition from the design argument to God's sensorium, on both occasions, Newton introduces the will of animals and humans into the account of divine design. In the second discussion of the sensorium of God, this leads Newton to refer to the mysteriousness of the way we can move our bodies by our will, and to the suggestion that God can move the bodies in the infinite space of the universe merely by exercising his will.

This repeated sequence is all the more striking, because each of the three elements in the sequence only ever appear in the *Quaestiones*, and later in the *Queries*, at these two points. The only two places in the *Queries* where the sensorium of God is mentioned, are also the only two places where the argument from design is invoked, and the only two places in the 1706 *Optice*, where the cause of gravity is discussed.¹³ It seems clear, then, in spite of the somewhat obscure and elliptical way of introducing the sensorium of God into *Quaestiones* 20 and 23, and later *Queries* 28 and 31 (based merely on idiosyncratic correlation, rather than logical entailment), that Newton associated God's sensorium with attempts to explain gravity. So, we need to consider just what Newton had in mind—how did talk of the sensorium of God help to explain gravity?

The cause of gravity was a real problem for Newton. Gravity, according to him, was an attractive force operating between bodies, and this attractive force was capable of operating across vast distances of empty space. For most of his contemporaries this was a completely unacceptable theory of gravity. The standard view, held by traditional scholastic philosophers and by those who subscribed to the new mechanical philosophy of Descartes alike, was that bodies could *only* act on one another by contact. For the mechanical philosophers, therefore, the reason why bodies fell to Earth was not because the Earth attracted them, but because there are streams of invisibly small particles perpetually descending towards the Earth which push anything above the Earth down towards its surface.¹⁴ It was these mechanical philosophers Newton was referring to when he wrote that they had “banished” the correct cause of gravity, instead “feigning Hypotheses for explaining all things mechanically” (*ibid.*, 369). Newton explicitly denied this mechanical explanation of gravity. There was, after all, no evidence in its favor. It was, as Newton pointed out in the General Scholium which he added to the second edition of the *Principia* (1713), merely an unsupported hypothesis and was not in any way “deduced from the phenomena.” These were the kind of hypotheses that “have no place in experimental philosophy,” and famously Newton refused to countenance them (Newton 1999, 943).

For Newton, gravitational effects demonstrated that bodies were capable of acting upon one another without making contact (Henry 2019; Henry 2020).¹⁵ Given that the force of gravity was clearly able to penetrate “as far as the centers of the sun and planets without any diminution

¹³By the time this appeared in print in English, there was a third place where gravity was discussed. Newton added eight more *Queries* to the 1717 edition, one of which, inserted as a new *Query* 21, offered a universal aether as a tentative cause of gravity. He added it, he tells us, to enable him to dismiss charges that he held gravity to be “an essential Property of Bodies” (*ibid.*, cxxiii). Having added it, however, he never mentioned it anywhere else again, much less developed it to see whether it could account for the inverse square law, or the direct proportionality of gravity to mass. Even with the addition of this one-and-only speculation about an aether, therefore, the historical evidence suggests that the mature (i.e. post-*Principia*) Newton never took any aetherial account of gravity seriously. See also note 26 below.

¹⁴I am simplifying, but this essentially captures the mechanistic account, which had to involve contact action between the falling body and the invisible bodies, which were held to cause its downward motion. For fuller accounts, see Gaukroger 2002, 165–66; and Schuster 2013, 478–98.

¹⁵In an age when the leading natural philosophers throughout Europe subscribed to the Cartesian mechanical philosophy Newton was coy about explicitly stating his belief that bodies gravitated at a distance in the *Principia*. Even so, it was perfectly obvious to thinkers such as Christiaan Huygens and Leibniz. Furthermore, Newton invoked actions at a distance quite explicitly in the *Opticks* and *Optice* (see, for example, Newton [1717] 1979, 319, 327, 332, 336–37, 338, 339, 363, 371, 376). Inexplicably, these explicit endorsements of action at a distance by Newton have attracted less scholarly attention than a comment in a letter from Newton to Bentley which was never intended for publication, which was written in haste, and in which Newton seems, at a casual glance, to deny the possibility of action at a distance (Letter to Bentley, February 25, 1692/3, in Newton 1978, 302–03). In fact, if read carefully it is clear that Newton was *not*, on this one occasion, contradicting

of its power to act” (Newton [1687/1713] 1999, 943), as he wrote in the General Scholium, it was presumably an immaterial force. It was a standard belief, unanimously accepted, that matter could not interpenetrate matter; two particles of matter could not occupy the same place at the same time. Accordingly, if the force of gravity could penetrate to the centre of material bodies, it must be an immaterial force. This only raises further problems, however. If the force of gravity could penetrate bodies without the process of penetration affecting the force in any way, how could the force move the bodies it was penetrating? Effectively, it was the same problem as the mind/body problem—how does the immortal soul, or the immaterial mind, cause the body to move? A body needs to be pushed or pulled to set it in motion, but how can something immaterial, which by definition simply passes through bodies, also provide bodies with impulsion or traction?

Although the operation of such immaterial forces remained unexplained, Newton and his followers believed that we have easy access to abundant evidence that immaterial substance can, one way or another, move bodies. We only have to raise our arms, or jiggle our toes.¹⁶ As Newton himself had noted in his unpublished speculative piece, known by its incipit as “De gravitatione,” “each man is conscious that he can move his body at will, and believes further that all men enjoy the same power of similarly moving their bodies by thought alone . . .” (Newton [c.1672 or c.1684?] 1962, 138).¹⁷

We can put this together with a comment made later by John Locke in his *Essay Concerning Human Understanding*. In the chapter “On Power,” Locke wrote:

If we will consider it attentively, Bodies, by our Senses, do not afford us so clear and distinct an Idea of active Power, as we have from reflection on the Operation of our Minds . . . The Idea of the beginning of Motion, we have only from reflection on what passes in ourselves, where we find by Experience, that barely by willing it, barely by a thought of the Mind, we can move the parts of our Bodies, which were before at rest. (Locke 1690, II. 21.4)

If we want to understand how motion is initiated, we should not consider bodies, but the working of our will. We can make our own bodies move just by an act of will.

One of the most remarkable features of “De gravitatione” is Newton’s attempt to explain the nature of body solely in terms of “extension and an act of the divine will” (Newton 1962, 140). Newton suggests “that God, by the sole act of thinking and willing, can prevent a body from penetrating any space defined by certain limits” (*ibid.*, 139). He goes on from there to show that such a region of impenetrable space might be made indistinguishable from body (reflecting light, sounding when struck, and so forth), and that indeed all bodies may be constituted in exactly this way.

[I]f there is any difficulty in this conception [Newton writes,] it is not in the form God imparts to space, but in the manner in which he imparts it [i.e. by his will]. But that is

the belief in action at a distance that he professed elsewhere in his work from 1679 onwards, and in print from 1704. For further discussion, see Henry 2019.

¹⁶I am fully aware, of course, that in our secular age exercise of our will to move our bodies no longer counts as evidence that the immaterial can move the material. And, therefore, that many will insist it never did. As far as Newton and most of his contemporaries were concerned, however, it certainly did, and anyone who denied it would have been dismissed as a fool, or a materialist (the latter entailing also the former). This was, after all, the age when Descartes, after observing that if he ever ceased to think he could have no reason to believe he existed, could immediately conclude: “From this I knew I was a substance whose whole essence or nature is to think, and which does not require any place, or depend on any material thing, in order to exist.” See Descartes [1637] 1985, 127. For John Cottingham, Descartes commentator, this “is, or ought to be, regarded as one of the most notorious nonsequiturs [*sic*] in the history of philosophy” (Cottingham 1992, 242). I suggest, however, that it ought *not* to be regarded as a non sequitur by *historians* of early modern philosophy, since nobody saw it as such when Descartes wrote it.

¹⁷The dating of “De gravitatione” is contested between c. 1672 and c. 1684, either way, Locke’s *Essay* was written later. Commentators tend to favour the earlier dating; see Steinle 1991, and Ruffner 2012; but the online Newton Project lists it as “mid-1680s”; <http://www.newtonproject.ox.ac.uk/catalogue/record/THEM00093> (last accessed September 1, 2020)

not to be regarded as a difficulty, since the same question arises with regard to the way we move our bodies, and nevertheless we do believe that we can move them. If that were known to us, by like reasoning we should also know how God can move bodies, and . . . cause space to be impenetrable and assume the form of body. (Ibid., 141)

It seems clear that Newton was very pleased with this speculation, and saw it not only as offering a new account of body, but also as extending the ways in which we are supposed to be made in God's image (by showing the similarity between our will and God's):

Thus I have deduced a description of this corporeal nature from our faculty of moving our bodies, so that all the difficulties of the conception may at length be reduced to that; and further, so that God may appear (to our innermost consciousness) to have created the world solely by the act of will, just as we move our bodies by an act of will alone; and, moreover, so that I might show that the analogy between the divine faculties and our own may be shown to be greater than has formerly been perceived by philosophers. (Ibid., 141)

But Newton never published this, and he never returned to this concept of body in any later work. It does seem clear, however, that he adapted these ideas many years later, in order to offer a solution to the problem of the cause of gravity. If we can move the parts of our bodies by an act of will in our sensoriums, then God can move any and every body in infinite space, or, which is effectively the same thing, every body "within his boundless uniform Sensorium" (Newton 1979, 403).¹⁸ Newton's speculation that infinite space might be somehow analogous to the sensorium of God, and that everything in the universe, therefore, might be said to be in God's sensorium, enabled him to offer an explanation for what seemed to be gravitational attraction at a distance—it was God who brought about the movements we attribute to gravity. Newton might have repeated, slightly changed, the comment we have just seen him make in "De gravitatione": "Thus I have deduced a description of *gravity* from our faculty of moving our bodies."

We have independent evidence that Newton was indeed thinking along these lines. David Gregory, Savilian Professor of astronomy in Oxford, had privileged access to Newton and tells us of what they spoke about on December 21, 1705:

Sir Isaac Newton was with me and told me that he had put 7 pages of Addenda to his book of Light & Colours in this new latin edition of it . . . His Doubt was whether he should put the last Quære thus: *What the space that is empty of body is filled with*. The plain truth is, that he believes God to be omnipresent in the literal sense; And that as we are sensible of Objects when their Images are brought home within the brain, so God must be sensible of every thing, being intimately present with every thing: for he supposes that as God is present in space where there is no body, he is present in space where a body is also present. But if this way of proposing this his notion be too bold, he thinks of doing it thus. *What cause did the Ancients assign of Gravity*. He believes that they reckoned God the Cause of it, nothing els, that is no body being the cause; since every body is heavy. (Hiscock 1937, 29–30; emphasis in the original)

So, Gregory confirms here that when Newton was thinking about God's omnipresence and his intimate presence to everything in the world, he was also thinking about the cause of gravity.

A draft of Query 23, written in English, also shows the link in Newton's mind between the sensorium of God and gravity:

¹⁸On the existence of infinite space in God (*not* God in infinite space), see Henry and McGuire 2018.

Thinking is an active principle by which we move our bodies according to our will, & thence arise other laws of motion unknown to us, which if all the Universe be the sensorium of a thinking Being, may be of greater entent. Gravity was reckoned among the laws of motion by the ancient Philosophers who attributed gravity to their Atoms in vacuo, & the forces above mentioned by which smal bodies act on one another at small distances may have a good a title as gravity to be reckoned among those laws. (Newton c. 1704–1718, Cambridge University Library MS Add. 3970.3, f. 620v)¹⁹

In the second mention of God’s sensorium in the published *Optice*, Newton was suggesting that just as we can move the parts of our own bodies by an act of will, so God can move the bodies in his “boundless uniform Sensorium”; that is to say, he can move the bodies in infinite space, merely by willing it. Accordingly, if a reader were to enquire about the cause of gravity, Newton had provided himself with a ready answer: the will of God is the cause of gravity.

Primary and secondary causes of gravity in the *Queries*

Newton did not leave it there, however. If he simply believed that God was the immediate cause of gravity then we would have to see Newton as a fellow-traveller with Continental Cartesian occasionalists, or at least as a thinker who allowed far more divine intervention in the world than was usual outside the ranks of the occasionalists. Indeed, evidence suggests that Newton’s position came close enough to the view that God was solely and immediately responsible for gravity that a number of his close associates believed that was his view. In the early 1690s, Newton’s friend and admirer, Nicolas Fatio de Duillier, and Christopher Wren both seemed to think that Newton believed gravity was caused directly by the will of God (Westfall 1980, 509–10). Similarly, we have seen that Gregory seemed to suggest in 1705 that Newton believed God to be the immediate cause of gravity.²⁰

Certainly, Leibniz, writing in 1716, insisted that Newtonian gravity was “a supernatural thing” because it could not be “explained by the nature of things” (Leibniz’s Fourth Paper, §45, in Alexander 1956, 43), but only by supposing it is “God himself that performs it” (Leibniz’s Fifth Paper, §118, in Alexander 1956, 94). Furthermore, a number of modern commentators have followed suit and insisted that Newton believed in the direct intervention of God in the world, in order to bring about gravitational effects. R. S. Westfall suggested that “God was an incorporeal aether who could move bodies,” and that “every movement in the world was the immediate effect of His power” (Westfall 1971, 397, 398). Andrew Janiak has taken a similar line:

Newton obviously thinks that God might be the very “immaterial medium” underlying all gravitational interactions among material bodies, it seems clear that when Newton contemplates the idea that God might be the relevant mediating element he is not contemplating the idea that bodies act at a distance on one another. Instead, God acts locally and directly on any object at any time. (Janiak 2008, 39)²¹

¹⁹Available online at <http://www.newtonproject.ox.ac.uk/view/texts/normalized/NATP00055> (last accessed September 1, 2020)

²⁰In fact, Gregory does *not* say that Newton believed God was the direct cause of gravity. He says that Newton believed God to be “omnipresent in the literal sense.” and that he believed the *Ancients* (or some of them) held that God was the direct cause of gravity (Hiscock 1937, 29–30). It was Gregory who recorded that Fatio and Wren suggested that Newton attributed gravity to God, but it is by no means clear they meant this in an occasionalistic way. In both cases it could just have been an acknowledgement that he saw God as the ultimate first cause of the secondary cause of gravity (Westfall 1980, 509–10). Even so, some modern commentators, as discussed immediately below, have taken this as evidence that Newton believed God was the immediate cause of gravity.

²¹Janiak’s “immaterial medium” seems to owe something to Westfall’s “incorporeal aether,” which in itself is a bizarre notion, unsupported by anything in the historical record. Aethers were always conceived to be material, albeit extremely

Similarly, for Geoffrey Gorham, Newton's position was "very close to the occasionalist view" (Gorham 2011a, 24, see also 25, 32).

It might be supposed that I am now adding my voice to theirs by insisting that Newton believed gravity was caused simply and immediately by God's will. However, it seems to me to be perfectly clear from the whole tenor of Newton's writings, published and unpublished, that he was neither an occasionalist, nor close to being one. In spite of his suggestion in *Quaestio* 23 and Query 31 that God can move every body in the universe simply by an act of his will, it is evident that he did not regard God as the *only* cause operating in the universe. Moreover, he certainly does not continually refer his readers to the will of God to explain phenomena—neither in this query, nor elsewhere in his writings. On the contrary, he continually refers his readers to the regularly operating secondary causes in nature through which the primary cause, God, has chosen to operate. "The main Business of natural Philosophy," he wrote in Query 28, "is to argue from Phaenomena . . . and to deduce Causes from Effects, till we come to the very first Cause" (Newton [1717] 1979, 369). We arrive at the first cause, God, at the end of a process of deduction based on earlier secondary causes, derived from our observation of phenomena. This is abundantly clear just from the Queries, where God is only invoked in the discussions leading up to the two mentions of his sensorium; otherwise Newton explains phenomena throughout by reference to natural causes—usually attractive and repulsive forces operating from the particles of bodies (e.g. Newton [1717] 1979, 339, 371, 372, 373, 375–76, 383, 384, 385, 386, 389, 391, 392, 393–94, 395). Similarly, although Newton writes in the General Scholium (added to the second edition of the *Principia* in 1713) that the world is contained in God, "In him all things are contained and move," he immediately goes on to say that "he does not act on them" (Newton [1687/1713] 1999, 941). This is obscure, but it seems to mean that God does not act directly on "all things", preferring to let them act in their own right (in accordance with the laws of nature he has instituted) as secondary causes. It is shortly after this that he reminds us that he has "explained the phenomena of the heavens and of our sea by the force of gravity;" and declares "that gravity really exists and acts according to the laws that we have set forth" (*ibid.*, 943). In taking this line—that the primary cause, God, chose to operate through natural secondary causes—Newton was simply accepting the standard view, embraced by natural philosophers and theologians alike (except for the occasionalists).

It can be seen just how far from being an occasionalist Newton was by comparing him with his close friend Samuel Clarke. Clarke has recently been convincingly revealed to be a "partial occasionalist" who believed that gravitational effects could only be brought about by the direct intervention of God, or by angels delegated by him (Sangiaco 2018). In order to convince his readers that the direct intervention of God is required to make an apple fall to the ground, or to keep Saturn in its orbit, Clarke has to first demonstrate (at least to his own satisfaction) that material bodies are categorically passive and inert, and that not even God can endow bodies with active powers, such as the power of attraction. It is the nature of bodies to be inert, Clarke insists, and not even God can change that (Henry 2020).²² Accordingly, Clarke argues, what looks like

tenuous in their materiality. I have never seen any early modern thinker who conceived of an "aether" that was held to be immaterial; and certainly, Newton never came up with such an idea. Aethers were conceived as a way of *avoiding* actions at a distance—i.e. actions which did not involve material contact between interacting bodies—by providing an all pervasive material medium in between all bodies. Consequently, to invoke an *immaterial* aether was to completely miss the point, and would have been regarded by natural philosophers as an utterly useless conception. Westfall's invention of an *incorporeal* aether seems to have been merely metaphorical—a way of regarding God if, as Newton says, "In him all things are contained and move" (Newton [1687/1713] 1999, 941)—but Janiak erroneously presents his "immaterial medium" as a real feature of Newton's philosophy (he calls it a "brief but significant speculation" by Newton, Janiak 2008, 39). This seems to be based on the mistaken assumption that Newton's insistence that gravity could not be enacted "without the Mediation of any thing else" (Letter to Bentley, February 25 1692/3, in Newton 1978, 302, which Janiak cites at this point in his discussion) was a reference to a medium, rather than to the act (by God) of mediating. For fuller discussion, see Henry 2019. The important point, anyway, is that Newton never would have, and never did, conceive of an *immaterial* aether.

²²Significantly, this suggests that Clarke was an intellectualist in his theology, and believed that God did not have a completely free hand in the Creation, but had to comply with co-eternal (i.e. already established or foreordained) moral

gravitational attraction has to be brought about by God, or angels, moving the relevant bodies in the appropriate ways (in accordance with the law of gravity). There is nothing like this in Newton's writings. Nowhere does Newton claim that bodies cannot be endowed with powers, much less that God cannot bestow such powers. On the contrary, Newton routinely refers to the powers of bodies, including their attractive and repulsive powers (Heimann and McGuire 1971; Downing 2014; Henry 2020). Moreover, Newton was a voluntarist in his theology and consequently did not believe that God's creative power was restricted by foreordained essences or natures of things. While Clarke insisted that the nature of bodies was such that not even divine omnipotence could make bodies active, for Newton, if God wished to superadd activity to passive matter, he just could (Henry and McGuire 2018; Henry 2020).

Accordingly, we can discern what is effectively another explanation for gravity in *Quaestio* 23 and Query 31—that is to say, an explanation for gravity that does not refer to the direct intervention of God. Right at the outset of this Query Newton reminds his readers that “it's well known, that Bodies act upon one another by the Attractions of Gravity, Magnetism, and Electricity” (Newton [1717] 1979, 376). Having shown throughout this longest of the queries how the “small Particles of Bodies” attract one another and thereby explain chemical phenomena, Newton finally comes to gravity:

And thus Nature will be very conformable to her self and very simple, performing all the great Motions of the heavenly Bodies by the Attraction of Gravity which intercedes those Bodies, and almost all the small ones of their Particles by some other attracting and repelling Powers which intercede the Particles. (Ibid., 397)

After a digression in which he dismisses the Cartesian claim that the “quantity of Motion in the World” is always the same, Newton returns to gravity:

Seeing therefore the variety of Motion which we find in the World is always decreasing, there is a necessity of recruiting it by active Principles, such as are the cause of Gravity . . . and the cause of Fermentation . . . (Ibid., 399)²³

The cause of Gravity is now said to be one of several active Principles at work in the world. It is at this point, somewhat abruptly, that God is brought in to the exposition:

All these things being consider'd, it seems probable to me that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the end for which he form'd them . . . (Ibid., 400)

These “other Properties” include the aforementioned active principles:

and natural principles. Given that Clarke wrote as a voluntarist theologian in his correspondence with Leibniz, when he was defending Newton's position against the criticisms of Leibniz, the correspondence shows Clarke's devotion and loyalty to Newton, who was a voluntarist through and through (Oakley 1961). On Clarke's voluntarism in the correspondence with Leibniz, see Henry 2009; on his intellectualism when presenting his own position, see Henry 2020.

²³Newton is denying here the Cartesian claim that motion is never lost from the world, but maintained at the same overall level as at the Creation, by God acting in accordance with his immutability. The Cartesian claim was subsequently investigated experimentally, including by Newton himself. Newton was thereby able to insist that motion would continually decrease, and the whole world system would grind to a halt, “if it were not for these [active] Principles” (Newton 1979, 399). On Newton's experimental investigations, see Murray et al. 2011, and Harper 2012.

It seems to me farther, that these Particles have not only a *Vis inertiae*, accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active Principles, such as is that of Gravity . . . (Ibid., 401)

Newton is by no means clear in his exposition at this point. Having first of all suggested that there is an active principle which is “the cause of Gravity,” he now tells us that gravity is an active principle. Perhaps his meaning is simply that gravity is a principle of activity placed in matter by God, and therefore, it can be said that the cause of gravity simply is the active principle. In the same way that heat might be said to be an active principle placed in fire, and so we can refer to the active principle as the cause of heat in fire. Or perhaps Newton is simply writing loosely or hastily. After all, he continues the quotation above:

such as is that of Gravity, and that which *causes* Fermentation, and the Cohesion of Bodies. (Ibid., 401)

So, what he really meant to say was, “such as that which causes gravity, and that which causes Fermentation, and that which causes Cohesion.” It seems safest to assume, therefore, that Newton saw active principles as the *causes* of phenomena such as gravity, fermentation, cohesion, magnetism, electricity, and the other “attractive Powers” that he mentions in the course of this query. In this regard, they are similar to the active principle which is said to enable us to move our own bodies: “Thinking is an active principle by which we move our bodies according to our will”, Newton wrote (Newton c. 1704–1718, Cambridge University Library MS Add. 3970.3, f. 620v). So, gravity is an attractive power which moves bodies, and is caused by an active principle in bodies.

Almost immediately, however, he complicates the issue again by saying that he considers these active principles to be laws of nature:

These Principles I consider not as occult Qualities, supposed to result from the specific Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd; their Truth appearing to us by Phaenomena, though their Causes be not yet discover'd. (Ibid.)

This is very problematic, and seems irresolvable. At first, an active principle is said to be the cause of gravity, and this principle is a law of nature; but then we are told that things are formed by the laws of nature, even though the causes of these things are not yet known (ibid.). Newton seems to say that laws of nature (active principles) are the cause of things, and then to suggest that there are unknown causes operating in a regular way, which enable us to formulate laws.

Newton is clearly unaware of his confusion—or, at least, unaware that he is writing in a way that readers can only find confusing. Although necessarily speculative and ultimately undecidable, I believe it is possible, by close reading, to understand how Newton went astray here.

If we start at the beginning of the paragraph, Newton tells us that particles of matter have a *Vis inertiae*, a force of inertia, and this ensures that the particles follow certain laws of nature (laws which are entailed by the existence of inertia): “Particles have . . . a *Vis inertiae*, accompanied with such passive Laws of Motion as naturally result from that Force” (ibid.). Clearly, Newton is referring here to the three laws of motion which appear at the beginning of the *Principia* (all of which are indeed based on the principle of inertia) (ibid., 416–17). So, inertia determines how bodies move (as summed up in the three “passive” laws of motion), but, he goes on, their movements are also determined “by certain active Principles, such as is that of Gravity . . .” It should follow, therefore, that just as inertia leads us to laws of motion, so should the active principles. Passive inertia leads to passive laws, active principles lead us to active laws—such as the law of gravity. Presumably Newton believed that there must also be laws of fermentation, of cohesion, of

magnetism and of electricity, and of the probably existing “more attractive Powers than these,” but these laws have not yet been discovered (Newton [1717] 1979, 376).

Now, one reason we know the law of gravity is correct is because the truth of it appears to us from the way it coincides with our daily experience of gravitational effects. This is what Newton means when he writes that things themselves are formed by the laws, “their [the laws’] Truth appearing to us by Phaenomena” (ibid., 401). So, at this point everything seems clear. Newton believes that empirical phenomena lead us to the conclusion that there is an active principle which is the cause of gravity. This active principle acts in such a regular and predictable way that we can arrive, indeed we have arrived (thanks to Newton), at a law of gravity. The validity of the law then establishes that the starting premise—that gravity is caused by an active principle—is correct.

Things go wrong, I believe, because Newton is tempted at this point to digress into a response to charges that he has reintroduced occult qualities into natural philosophy. The digression has all the hallmarks of something developed separately from this discussion of the cause of gravity. Perhaps Newton had already decided that the way to dismiss this charge was to distinguish, as he does here, between “manifest Effects” and occult causes. Gravity, magnetism, and electricity have very visible and striking effects, and we can learn a great deal from those effects, even if we do not know how they are caused. This was a perfectly standard way of defending the use of unexplained effects within Baconian experimental philosophy (Henry 1986), and Newton is simply adopting it here.

We can see this for example, in Robert Boyle’s *New Experiments Physico-Mechanical Touching the Spring of the Air and Its Effects* (1660). Undecided as to the cause of the elasticity of air, Boyle declares that it is not his intention “to assign the adequate cause of the Spring of the Air, but onely to manifest, That the Air has a Spring, and to relate some of its effects” (Boyle 2000, 1:167). Similarly, in his *Of the Systematicall or Cosmicall Qualities of Things* (1671), Boyle wrote:

And least you should think that under the name of *Cosmicall* Qualities I should introduce Chimæras into naturall Philosophy, I must betimes advertise you, that you will meet with divers Particulars in the following Discourse, fit to shew that these Qualities are not meerly fictitious Qualities: but such, whose Existence I can manifest, not only by considerations not absurd, but also by real Experiments and Physicall *Phænomena*. (Ibid., 6:288–89)

Similarly, Robert Hooke insisted that “unheard of Powers, Operations, Effects or Motions” could be introduced into natural philosophy providing an experimenter can “daily try, see, and find the regular working of them,” thereby bringing them “within our reach and command” (Hooke [1678] 1931, 179).

So, we can see this digression in Query 31 as Newton taking the opportunity to respond to accusations from Leibniz and other Continental mechanical philosophers that he was merely resorting to occult qualities in his discussion of gravity, by making what must have seemed to him (working in the heartland of Baconianism) a very obvious, and very effective response, namely, that he was dealing experimentally with manifest effects, which revealed the detailed operations of whatever caused those effects, even if those causes remained occult, or hidden (Newton [1717] 1979, 401).

Unfortunately, however, it was a feature of this standard Baconian response to accept that causes remained occult. Newton followed suit, and ended up implying that he did not yet have a casual account of gravity. So, Newton begins the paragraph by telling his readers that gravity is caused by an active principle placed in matter by God, but then allows himself to be diverted into dismissing charges that he resorts to occult qualities, and ends the paragraph by saying that he leaves the cause of gravity “to be found out” (ibid., 402).

Newton perhaps saw himself as introducing this standard Baconian defense of the use of occult or unexplained causes (legitimate if the effects of these causes can be demonstrated empirically) to Continental, and largely Cartesian, readers. This was prepared, after all, for the Latin edition of his

work on optics. Newton used the same Baconian argument a few years later in the General Scholium added at the end of the second edition of the *Principia* (1713). On this occasion, however, there was no contradiction. In the *Principia* Newton did not allow himself to speculate, and so he was perfectly correct to say, “I have not yet been able to deduce from phenomena the reason for these properties of gravity” (Newton [1687/1713] 1999, 943). Our concern here, however, is with the *speculative* causes for gravity that Newton had already provided at the end of the *Optice*, and later repeated in the 1717 *Opticks*, where he was “proposing only some Queries . . .” (Newton [1717] 1979, 339).

The Queries were added to the end of the *Opticks* as a way of rounding off what was essentially an unfinished work, and they provided Newton with the opportunity to put forward various speculations that he suspected were correct, but which he could not establish with any certainty. The material presented in the Queries, therefore, differs greatly from that presented in the *Principia*. Newton was heavily criticized for failing to provide a causal account of gravity in the first edition in 1687, and by the early 1690s (according to Fatio, Wren, and Gregory) he was evidently already thinking about the role of God in any putative explanation of gravity. Gregory tells us that he was thinking about these matters again in 1705, and in the *Optice* of 1706 he made public, in *Quaestio* 23, his belief that God could form and reform parts of the universe just by thinking about it. As we have seen, these speculations about God were closely linked to attempts to explain gravity, but gravity was not declared to be enacted solely and immediately by God because, as Newton wrote, “it may be also allow’d that God is able to create Particles of Matter . . . of different Densities and Forces” (ibid., 403–04). Gravity was said to be caused by active principles which God imposed on these Particles (ibid., 401).

By the time Newton was ready to publish the second edition of the *Principia*, in 1713, the musings about the cause of gravity in *Quaestio* 23 remained entirely speculative. Consequently, when Newton decided to discuss the nature of gravity in the General Scholium, which he added at the end of the revised *Principia*, rather than introduce his speculative account of gravity, he chose to meet Continental critics of his theory head-on. Their alleged casual accounts of gravity were entirely speculative and not deduced from phenomena, he forcefully pointed out, while his account, though lacking a supposed cause, was entirely derived from phenomena and “sufficient to explain all the motions of the heavenly bodies and of our sea” (Newton [1687/1713] 1999, 943).²⁴

Even so, when he issued the second English edition of the *Opticks*, Newton showed no reluctance to return to his earlier speculations. He added eight new Queries and made changes to some of the earlier ones (Hall 1993, 127–62), but he left his comments about the sensorium of God and the associated account of gravity unchanged. It seems clear from this that he felt that these particular speculations continued to point to something important about the nature of the world, and of God’s relationship with it.

One thing seems abundantly clear from Newton’s introduction of the sensorium of God into the *Optice*, and from the opinions of Fatio, Wren, and Gregory, as recorded in Gregory’s memoranda (Westfall 1980, 509–11; Hiscock 1937, 29–30), and that is that Newton felt a greater need to discuss the role of the primary cause than was usual in natural philosophy. Although all were agreed that God was the primary cause who established and maintained the smooth running of the secondary causes, it was usual to simply take God’s role for granted, and to focus discussion on the workings of the secondary sources. This had been the standard approach among natural philosophers since the Middle Ages (Grant 2007, 239–73). It was clearly important to Newton,

²⁴It is clear, however, that the General Scholium owed a great deal to the *Quaestiones* with regard to the nature of God. The discussion of God and his relationship to space (and time), and the claim that “In him all things are contained and move” can be seen as an expansion on the idea that infinite space is, as it were, the sensorium of God. It seems that Newton really did see this concept of God as deriving “from phenomena”, and therefore, was a legitimate aspect of “experimental philosophy” (Newton [1687/1713] 1999, 943; Newton [1717] 1979, 370; see also Henry and McGuire 2018).

however, that natural philosophy should help us to understand God as well as nature: as we have already noted, he wrote in the General Scholium that “to treat of God from phenomena is certainly a part of natural philosophy” (Newton [1687/1713] 1999, 943).²⁵

This may simply have been an aspect of Newton’s undeniably intense religious devotion. But, it may also have been a result of what Newton saw as the inherent difficulty of explaining to his contemporaries (especially as many of the leaders among them were mechanical philosophers) an attractive force that operated at a distance. The *Principia* demonstrated that gravitational attraction acted at a distance, across space that was devoid of intervening matter. The force of gravity had to be immaterial, therefore, and yet still be capable of moving matter. Newton must have known that this theory of gravity would attract dismissive criticism, or, if he did not know, he soon became aware of such criticism, from Huygens, Leibniz, and others. In order to persist in assuming that an immaterial force could move matter, Newton (presumably after long thought, throughout the 1690s and up to 1706) drew attention to the fact that our immaterial souls can move our bodies, though we do not know how we do it. If we can do that, then surely the omnipotent God can move all bodies, even though he is completely immaterial. The discussions of God’s sensorium in the *Quaestiones* are intended to bring this out. But, in case anyone should think that God must therefore be acting directly in the world he immediately cautions:

we are not to consider the World as the Body of God, or the several Parts thereof, as the Parts of God . . . they [the parts of the world] are his Creatures subordinate to him, and subservient to his Will . . . God is able to create Particles of Matter . . . of different densities and Forces, and thereby to vary the Laws of Nature. (Newton [1717] 1979, 403–04)

Newton could have chosen to say that God simply brings about gravitational effects by his own direct intervention in the world, after all, French occasionalists had already taken this previously unprecedented line in natural philosophy. Newton did not sign up as an occasionalist, however, choosing instead to suggest that it appears “from Phaenomena” that God’s will decrees that bodies attract one another by an immaterial force. Even though we do not know how that is possible, it is not significantly different, Newton implied, from our ability to move our own bodies (without us knowing how that is possible). Furthermore, it is evident from the law-like way gravity behaves that it must have been established by God. Accordingly, God established active principles in the particles of matter which he created, and those principles cause an immaterial power of attraction.

Conclusion

We can see, then, that in *Quaestio* 23 Newton first of all proposed that gravity was caused by an active principle, evidently placed in matter by God. It was evident because, in spite of Descartes’s claims to the contrary, motion always decays and “there is a necessity of conserving and recruiting it by active Principles, such as are the cause of Gravity . . . and the cause of Fermentation . . .” (Newton 1979, 399). It was also evident to Newton that gravity, and the other attractive and repulsive forces discussed in the *Queries* acted at a distance, “for producing a great Part of the Phaenomena of Nature” (*ibid.*, 376). Conscious that this would have been dismissed as impossible by traditionalist scholastic thinkers, and by those mechanical philosophers who had not yet ameliorated their views with Baconian experimentalism, Newton added that gravity could be, indeed must be, understood as being caused by the will of God, for whom nothing was impossible. Newton believed that God, by an act of will, could simply enable matter to act on other matter at a distance, that is to say he could enable matter to act by immaterial means. Just as our immaterial immortal souls can move our bodies simply by an act of will in our sensoriums, so the

²⁵When the General Scholium first appeared in 1713, Newton wrote “experimental philosophy.” He changed it to natural philosophy for the 1726 edition. See Newton [1687/1713] 1999, 943, note.

immaterial God can move the bodies in the world by an act of will in his sensorium. These things being so, Newton believed, there is surely nothing to prevent God from enabling bodies to move other bodies by means of an immaterial force or power associated with an active principle.

Although Newton proposed that God's will, enacted in his sensorium or in infinite space, was the ultimate cause of gravity (and of everything else), he did not intend thereby to exclude secondary causes from nature. On the contrary, his usual way of proceeding was to explain natural phenomena in terms of natural secondary causes. "Drops of every fluid affect a round Figure by the mutual Attraction of their parts," he wrote, for example, "as the Globe of the Earth and Sea affects a round Figure by the mutual Attraction of its Parts by Gravity" (Newton 1979, 395). It seems clear, therefore, that Newton favored the view that gravity was an attractive power, caused by an active principle, imposed upon matter by God's will.²⁶

It might be objected, that these were merely speculations, and that Newton's real position was shown in the *Principia*, where, as we noted above, he remained non-committal with regard to the cause of gravity in the General Scholium. I believe a case could be made that Newton, even in the *Principia*, and in spite of his pretended refusal to commit himself, subscribed to the view that gravity was an attractive power in bodies—certainly, he writes throughout the *Principia* as though this is what he believes (e.g. Newton [1687/1713] 1999, 427–28, 445, 539, 562–73, 585–88, 806, 808, and *passim*)—and by the early 1690s (as we have seen) he was already thinking about the role of the first cause in bringing about gravitational effects.

But I have already gone on too long, so will not press this claim here. In the *Queries*, however, where he allowed himself to be more speculative (provided those speculations were justified "by phenomena"), he did suggest a dual-pronged cause of gravity: an active principle acting as the secondary cause, and God's will acting as the primary cause. Although speculative, the *Queries* were invested with great significance by Newton. As we saw R. S. Westfall intimating earlier, the evidence suggests that Newton was presenting ideas in the *Quaestiones* in which he really believed, and that they constituted "the fullest exposition of his own conception of nature he would ever put in print" (Westfall 1980, 648). Furthermore, as I. B. Cohen pointed out decades ago, in the *Queries*,

Newton does not ask in a truly interrogatory way (Qu. 1): "Do bodies act upon Light at a distance . . . ?"—as if he did not know the answer. Rather, he puts it: "Do not Bodies act upon Light at a distance . . . ?"—as if he knew the answer well—"Why, of course they do!" (Cohen 1979, xxxiii)

Similarly, when Newton asked, "does it not appear from Phaenomena that there is a Being . . . who in infinite Space, as it were in his Sensory, sees the Things themselves . . . and comprehends them wholly by their immediate presence to himself . . ." He believed he knew the answer very well.

²⁶In the 1717 edition of the *Opticks*, Newton introduced another causal account of gravity, in the newly interpolated Query 21. This new account of gravity was very different in character (relying on a supposed highly tenuous aether), and was very definitely an alternative to the speculations about gravity in *Quaestiones* 20 and 23 (which in the 1717 edition became *Queries* 28 and 31). This was the one and only appearance of this aether theory, in the 1717 and subsequent editions of the *Opticks*, and was never developed, or ever mentioned again in print by Newton. By no means as original as the sensorium of God theory, it derived from Robert Hooke's account of gravity in his *Micrographia* (Hooke 1665, 21). For a detailed discussion, see Wang 2018, Chapter 5, 203–42. By contrast, the earlier view, in which God's will imposes active principles upon matter which enables bodies to exhibit various powers, is compatible with Newton's alchemically-inspired commitment to vitalistic theories of matter, from the early 1670s onwards, which has now been established in no uncertain terms in Newman 2019.

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