

Robert Boyle and the Representation of Imperceptible Entities

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Abstract:

In this essay, I examine Robert Boyle's strategies for making imperceptible entities accessible to the senses. It is well known that, in his natural philosophy, Boyle confronted the challenge of making imperceptible particles of matter into objects of sensory experience. It has never been noted, however, that Boyle confronted a strikingly similar challenge in his natural theology – he needed to make an equally imperceptible God accessible to the senses.

Taking this symmetrical difficulty as my starting point, I propose a new approach to thinking about the interconnections between Boyle's natural philosophy and natural theology. For the most part, studies of science and religion in the early modern period work by seeking out the influence of explicitly stated religious beliefs on scientific ideas. I argue, by contrast, that we need to focus on Boyle's representational practices, using his attempts to represent imperceptible entities as a means of uncovering metaphysical and theological presuppositions that he did not always articulate when stating his religious beliefs.

With new interpretations of both *A Discourse of Things Above Reason* (1681) and *Some Physico-Theological Considerations about the Possibility of the Resurrection* (1675), I show that there were crucial similarities between Boyle's practices for representing both God and atoms. I go on to show, moreover, that Boyle used these practices to enact an ontological stance at odds with one his most important professed beliefs.

Introduction:

From its origins in the middle of the seventeenth century, the Royal Society of London advocated an empirical approach to the production of natural knowledge. Natural philosophers such as Robert Boyle argued that sensory experience, tempered by the exercise of judgment, would provide the foundation for a reformed philosophy of nature. Boyle sought to use this empirical strategy, however, to understand entities that lay far beyond the grasp of the senses. According to the most widespread accounts of the mind's inner workings, those objects were thought to be not just imperceptible, but completely unimaginable.

Consider first Boyle's pneumatic and chemical experiments. With these experiments, he sought to establish the corpuscular hypothesis, which attributed the properties of perceptible material phenomena to mechanically configured interactions between imperceptible clusters – 'corpuscles' – of infinitesimally small particles of matter. Even though Boyle regarded these particles as the most important objects of his experimental agenda, he nevertheless admitted their inaccessibility to the human faculties. In the *Discourse of Things Above Reason* (1681) he averred that the mind was unable to form images of particles so great in number, and so small in size: 'so extraordinary a littleness not having fallen under any of our Senses, cannot truly be represented in our imagination'.¹

Now consider Boyle's interest in using natural philosophy to find rational incentives for a belief in God. Like the naturalists John Ray (1627-1705) and Nehemiah Grew (1641-1712), he thought that the empirical investigation of nature could yield enough knowledge about God to form the basis of a new, empirical variety of natural theology, known by the name 'physico-theology'. All but the most heterodox thinkers of the seventeenth century agreed, however, that God was an entity at once infinite, and composed of an immaterial substance. This was a problem for natural philosophy, since none of his attributes, therefore, could be made accessible

to the finite, embodied organs of sensation, nor even to the immaterial-but-still-finite soul. An immaterial substance could never make impressions on the material organs of sensation, while an infinitely extended entity could never be represented as an object of experience. In *Things Above Reason*, Boyle therefore warned that it was ‘no less weakness than presumption to imagine that such finite Beings as our Souls, can frame full and adequate *Idea*’s’ of God’s infinite perfections.² In both natural philosophy and natural theology, therefore, Boyle addressed the difficulties arising from the desire to use the evidence of the senses to produce knowledge of imperceptible phenomena.

Seen in this light, the natural philosophy and physico-theology of the early Royal Society had much in common. Although they addressed different objects, both aimed to answer metaphysical questions – questions about the ultimate foundations of reality – by empirical means. However, the currently prevailing view is rather different. It holds that while natural philosophy and natural theology influenced one another a great deal, they nevertheless comprised distinct fields of activity. This view is expressed in two different ways. Scholars such as Scott Mandelbrote interpret the natural theology of the early Society primarily in apologetic terms. According to this reasoning, the use of evidence from nature to evince the existence and attributes of God served the purpose of deflecting accusations of religious impropriety, but had little to do with natural philosophy itself.³ Meanwhile, scholars such as Rhodri Lewis argue that the two fields were separated by their standards of proof and persuasion. As Lewis sees it, the purpose of natural philosophy was to produce knowledge of the physical world, while the aim of physico-theology was to induce belief in God.⁴ This line of thought gives us the impression that, while physico-theology depended in some measure on evidence from nature, it was chiefly the product of prior religious beliefs. It was the expression of a state of interior assent that could never have been acquired using the rational procedures of natural philosophy.

These positions both imply, albeit for different reasons, that natural philosophers identified a sharp distinction between theology, a realm of religious belief, and natural philosophy, a realm of knowledge proper for scientific inquiry. I do not think, however, that Boyle and his contemporaries could have embraced so strict a demarcation. Peter Harrison and Jonathan Sheehan have both recently produced forceful reminders that seeing theology as a matter of irrationally acquired belief – rather than rationally acquired knowledge – is a modern idea. It is no untoward generalization to point out that, during the medieval and much of the early modern period, theology was often regarded as a science, as much capable of producing demonstrative truths as philosophy. During the seventeenth century, however, the scientific status of theology came under pressure, with thinkers such as Descartes, Hobbes and Spinoza seeking to exclude an increasingly large number of theological questions from the domain of rational inquiry.⁵ Such efforts to consign theology to the realm of belief met with fierce resistance – not least on the part of many affiliated with the Royal Society. To pigeonhole the physico-theological work of philosophers including Boyle, Nehemiah Grew and John Ray as being concerned with mere belief would be, therefore, to take sides in what was at the time an unresolved debate. We must also recall that thinkers of the seventeenth century did not generally share today's belief that the sciences are incapable of providing meaningful answers to metaphysical questions. As Quentin Meillassoux reminds us in his recent book *After Finitude*, metaphysics came to be seen as a matter for religious belief only after the interventions of David Hume and Immanuel Kant in the second half of the eighteenth century. By contrast, thinkers such as René Descartes – and as we shall see, Robert Boyle – regarded questions about the fundamental conditions of existence and the ontological status of both material and immaterial entities as legitimate targets for philosophical investigation.⁶

To avoid the anachronisms flowing from today's distinctions between knowledge and belief, this essay will pursue an unusual approach to accessing the religious 'content' of Boyle's

natural philosophy. It will not follow the widespread assumption that explicit statements of belief are the most reliable means of understanding the religious ideas at work in early modern natural philosophy. It will focus, instead, on Boyle's representational practices, arguing that an analysis of his strategies for representing imperceptible entities – in works both of natural philosophy and theology – can enable us to identify the presence of theological and metaphysical concerns beyond the scope of his stated beliefs. This analysis will challenge the now canonical reading of Boyle's *Discourse of Things Above Reason* offered some twenty years ago by Jan Wojcik. Wojcik's reading holds that Boyle's theological voluntarism – his belief that God's relationship to creation was governed more by arbitrary will than by reason – led him to exclude theological questions from the domain of natural-philosophical inquiry. Boyle's representational practices, however, reveal a more mixed picture. In works of both theology and natural philosophy, Boyle enacted with these practices an ontological stance quite at odds with his own voluntaristic beliefs. Nowhere are the tensions between these two ontologies made clearer than in Boyle's *Some Physico-Theological Considerations about the Possibility of the Resurrection* (1675), an audacious attempt to subject one of the greatest Christian mysteries to the knowledge claims of natural philosophy. With a chemical experiment regarded as a decisive demonstration of the corpuscular hypothesis as its centrepiece, this work gives us a remarkable opportunity to see how Boyle mobilised strategies for representing imperceptible, unimaginable particles in his efforts to establish how much human reason could learn about an infinite God.

Focusing on Boyle's strategies for representing imperceptible entities thus makes it possible to identify metaphysics and theology in aspects of his thought not explicitly concerned with religious belief. At the same time, it gives an opportunity to reconsider the relationship between Boyle's approach to the production of theological knowledge, and those approaches pursued by fellow members of the Royal Society such as Grew and Ray. It is well known that Boyle's theological beliefs – in particular, his beliefs about how God imposed his will on

creation – marked him out from his contemporaries. As I have suggested, however, it is not always productive to assume that theology in the seventeenth century was the preserve of belief, or even that statements of religious belief are infallible guides to the religious ‘content’ of systems of natural philosophy. Focusing instead on Boyle’s representational practices, we will see that Boyle’s ontological assumptions were sometimes closer to those of his contemporaries than has often been assumed. Like Ray and Grew, he was caught between two almost contradictory desires, hoping to make God into an object of empirical knowledge while at the same time seeking to show that he was inaccessible to the human faculties.

An Unimaginable God

During the seventeenth century, the emergence of new accounts of the bodily organs of the mind raised difficult questions about how far God could be an object of human knowledge. Influential works of neurophysiology, such as Descartes’s *Treatise on Man* (posthumously published in 1662) and Thomas Willis’s *Cerebri Anatome, cui accessit Nervorum Descriptio et Usus* (1664), used mechanical terms to describe how the mind perceived and represented to itself the objects of sensory experience. Both Descartes and Willis regarded the ideas resulting from sensory experience as tiny material entities lodged in the brain. Physical impressions made by external objects on the organs of sensation were, they claimed, transmitted through the nerves to an organ situated in the brain – an organ capable of turning those impressions into ideas to be surveyed by the immaterial soul. This organ was the imagination, understood as a material entity that functioned in the same way as a highly complex machine. Contemporaries disagreed about the extent of the imagination’s role in furnishing the mind with ideas and intuitions. Some argued that the mind was more or less wholly dependent on the objects of sensation and imagination, while others claimed that it also had access to a realm of immaterial

intuitions. But there was broad agreement about the nature of the imagination itself. Philosophers who differed as widely in their views as Hobbes, Descartes, and Boyle all agreed that the imagination was capable only of representing to itself ideas resulting from sensory experience. They agreed, moreover, that the imagination could never picture entities that were themselves incapable of palpably affecting the senses. Objects too large or small to make impressions on the sensory organs, or those composed of immaterial substances that could not touch those organs, were unimaginable. It thus seemed clear that God, an immaterial entity of infinite extent, was unimaginable too.⁷

Thomas Hobbes and René Descartes both drew on such accounts of the imagination as they sought, in differing ways, to limit the role of the sciences in producing knowledge of God. For Hobbes, everything in the universe – including thought itself – was the product of mechanical interactions between particles of matter. As a result, he held that the finite, bodily mechanisms of sensation and the imagination were the only instruments with which the mind could supply itself with ideas. He thus argued in *Leviathan* (1655) that the mind could never possess an idea of God:

Whatsoever we imagine, is Finite. Therefore there is no Idea, or conception of anything we call Infinite. No man can have in his mind an Image of infinite magnitude; [...] And therefore the Name of GOD is used, not to make us conceive him; (for he is Incomprehensible; and his greatnesse, and power are unconceivable;) but that we may honour him.⁸

For Hobbes, the finitude of the imagination made an infinite God completely unthinkable. By contrast, Descartes divided up the functions of the mind between its bodily organs and an

immaterial, immortal – albeit finite – soul. This soul, he claimed, could deduce the existence of an infinite God by purely intellectual acts – acts that took place in a spiritual realm completely independent of the mechanisms involved with sensory experience. At the same time, however, Descartes concurred with Hobbes's assessment of the imagination. In the *Meditations and Objections and Replies* he explained that the finite imagination, and its equally finite objects in the world of sensory experience, were incapable of revealing anything informative about the attributes of God. This position entailed an outright rejection of physico-theology, premised on the argument that its objects – natural phenomena accessible to the senses – were incommensurate with an infinite God. For Descartes, God could never be made into an object of aesthetic experience. Only the rational soul, performing intellectual acts independent of experience, could apprehend any of God's attributes.⁹

In many of their writings, Boyle and his contemporaries in the Royal Society gave the appearance of agreeing with what Descartes had said. In *De Anima Brutorum quae Homine Vitalis ac Sensitiva est* (1672), for example, Willis sought to show that the 'rational soul' could access ideas that were 'by no means to be learnt from Sense or Phantasie [imagination]'. Among these ideas, he included some of the most important tenets of natural religion, including God's infinity, the requirement to worship him, the existence of incorporeal beings such as angels, and the existence of heaven and hell.¹⁰ In *Things Above Reason*, meanwhile, Boyle used a similar line of thought to criticize Hobbes's argument that immaterial entities were unintelligible simply because they could not be imagined:

[...] those that are wont to employ their imaginations about things that are the proper Objects of the Intellect, are apt to pronounce things to be unconceivable, only because they find them unimaginable; as if the Fancy and the Intellect were

Faculties of the same extent: Upon which account some have so grossly err'd,
as to deny all immaterial Substances [...]

Boyle identified Hobbes's error as a failure to recognise the difference between the imagination and the intellect. He agreed that any attempt to represent immaterial entities with the imagination would end in failure. However, he did not agree that the imagination was the mind's only faculty. Like Descartes, he claimed instead that the possession of an immaterial intellect enabled the mind to reason about incorporeal beings even though the organs involved with sensation and imagination could never apprehend them.¹¹

It is clear that Boyle and his contemporaries were far more interested in using sensory experience to learn about God than they were sometimes willing to admit. Indeed, the naturalists Nehemiah Grew and John Ray remain famous to this day for their works of physico-theology, wherein they argued that the investigation of design in nature could yield reliable insights into some of God's attributes and purposes. Meanwhile, Boyle argued for the value of physico-theology in his *Disquisition about the Final Causes of Natural Things* (1688). In this work, he engaged closely with Descartes's rejection of physico-theology, seeking to refute the French philosopher's claim that all of God's intentions lay equally concealed in the abyss of his infinite wisdom. He asserted instead that the design to be found in some natural phenomena was so 'manifest and obvious' that it would be foolish to reject the insights to be gleaned from them about God's wisdom and intentions. Indeed, he would claim in the *Disquisition* and elsewhere that practitioners of empirical natural philosophy could give a precise account of exactly how much wisdom God had displayed in the works of creation.¹²

Boyle and those of his contemporaries who committed themselves to physico-theology therefore held positions that seem contradictory. When answering the challenge posed by

materialist accounts of the mind, they emphasised the impossibility of subjecting an immaterial, infinite God to the bodily mechanisms of sensory experience. In the context of physico-theology, however, they asserted that sensory experience was a highly effective means of giving the mind access to such a God. We are left to wonder how they could, if at all, reconcile such sharply contrasting positions.

Robert Boyle Represents an Inconceivable God

The *Discourse of Things Above Reason* was Boyle's most highly developed reflection on the question of God's accessibility to the human faculties. Examining this work in more detail will enable us to see how he attempted to balance the assertion of God's unintelligibility against a desire to use the imagination and senses as instruments of theological knowledge. Although presented as a friendly dialogue between four participants, the book's argument appears at first sight to be both clear and unambiguous. From the outset, however, it is worth pointing out that the clarity of Boyle's argument was in some sense a rhetorical posture. As Michael Hunter has shown in his work on Boyle's interest in casuistry, Boyle entertained private doubts that belied his public certainties.¹³ In *Things Above Reason*, Boyle argued that some matters lay completely beyond the reach of the human mind, inaccessible both to its bodily organs and to the immaterial soul. He described such matters as 'things above reason'. This category included not only the nature of God and his attributes, but also points of doctrine that defeated rational explanation, such as the apparently irreconcilable coexistence of God's necessary ability to know the outcome of every future event with the lived experience of free will and independent agency.¹⁴ On closer inspection, however, *Things Above Reason* turns out to offer a remarkably ambiguous account of how the human faculties could reckon with such matters.

Boyle's aim was to persuade philosophically minded readers that they should embrace Christianity in spite of the fact that its revelations contained doctrines that defeated rational explanation or even comprehension. He made his case by reminding them how often they were willing to entertain similarly unintelligible notions – such as hypotheses about the forms and behaviour of imperceptible atoms – when it came to mathematics and natural philosophy. He therefore did not see matters of religious faith as the only ones that transcended the capacities of reason. He included in the same category paradoxes flowing from the contemplation of infinite numbers and quantities in both mathematics and natural philosophy, using them to illustrate the impossibility of understanding an equally infinite God. Boyle thus delineated three kinds of truth that he thought it necessary to accept, despite their evident unintelligibility – ‘incomprehensible’, ‘inexplicable’, and ‘unsociable’. The infinite perfections of God were *incomprehensible* because the finite human faculties could never form adequate ideas of them. Meanwhile, *inexplicable* truths were those that could be perceived or intuited but not explained. Boyle illustrated this kind of truth using the paradox of the infinite divisibility of matter, a point that could be demonstrated mathematically but that defied physical explanation. Finally, *unsociable* truths – and here Boyle had in mind the difficulty of reconciling divine foreknowledge with the experience of free will – were those that appeared to contradict one another. He exemplified this final category by referring again to infinite divisibility, pointing out the apparent contradiction involved in the mathematical demonstration that lines of different lengths must nevertheless be divisible into the same infinite number of parts.¹⁵

Since Boyle adopted an irenic authorial persona, addressing debates indirectly and rarely naming his opponents, it can be hard to identify the targets of his apologetic and controversial works. Nonetheless, Wojcik argues that Boyle saw *Things Above Reason* as an intervention in two contemporary theological debates. The first, which had been brewing in England since the 1650s, concerned the perceived threat of Socinianism. This was a brand of

theology that saw human reason as the criterion by which to judge the truth of scriptural revelation. Socinians thus rejected important Christian mysteries because they seemed impossible when subjected to rational scrutiny. Placing such mysteries beyond the grasp of reason enabled Boyle to neutralise this attack on revealed religion.¹⁶ At the same time, as Wojcik goes on to argue, Boyle sought to intervene in a recent outbreak of the interminable debate about predestination. For Calvinists, God's necessary foreknowledge of future events implied that free will was more or less illusory – individuals were predestined for heaven or hell by divine decree. Opponents of this severe doctrine – such as the nonconformist divine John Howe, who wrote at Boyle's urging – responded by arguing that such a strong account of predestination was inconsistent with God's goodness because it made him responsible for human sin.¹⁷ Here, Boyle sought to calm disputes between rival groups of Protestants. By once again placing a matter of revealed religion outside the grasp of reason, he could hint at the futility of attempts to solve the paradoxes of predestination by rational means. Neither side, in Boyle's view, could legitimately claim a greater share of truth than the other.¹⁸

At one level, therefore, Wojcik explains Boyle's position in terms his involvement with contemporary theological controversies. She goes on, however, to argue that there was an even more powerful agent at work – Boyle's religious belief. She thus gives belief a causal status in Boyle's thought, identifying it as the motivation not just for his theology, but also for his natural philosophy. 'Boyle's theological beliefs', she writes, 'provided the foundation for his views on natural philosophy'.¹⁹ It is well known that Boyle was committed to a position now referred to as theological voluntarism, a position that is usually contrasted – sometimes too sharply – with another view known as intellectualism. For an intellectualist such as the philosopher Henry More (1614-1687), the world could be understood through systems of reasoning – logic and mathematics, for example – because it was a stable product of divine wisdom, with God in some sense constrained by the logic of his own decrees. For voluntarists such as Boyle, on the other

hand, the world was utterly contingent on arbitrary decisions emanating from God's free will. Boyle's God could institute laws of nature, but might nevertheless choose to suspend those laws if, for instance, he wanted to communicate with humans through a supernatural sign – that is, a miracle. The role of voluntarism in Boyle's epistemology, and indeed in the emergence of empiricism more broadly, is well established.²⁰ To this familiar account, however, Wojcik adds an altogether more controversial claim. She argues that Boyle, extending the logic of voluntarism to his account of the human faculties, believed human and divine reason to operate according to entirely different principles. Thus Boyle's belief in theological voluntarism led him to place human reason and divine wisdom into different ontological categories, making God wholly inaccessible to rational investigation.²¹ Moreover, Wojcik regards Boyle's most important epistemological stance – the claim that natural philosophy was capable of yielding only probable knowledge rather than demonstrative certainty – as symptomatic of this deep-seated irrationalism. She argues, in other words, that Boyle limited his experimental programme to the production of probable knowledge because he saw the world, and human reason itself, as contingent outcomes of God's arbitrary will.²²

It is clear from Boyle's stated argument in *Things Above Reason* that he held and expressed such a belief in God's complete inaccessibility to human reason, premised at least in part on his radical voluntarism. It is less clear, however, that this belief decisively shaped his arguments about the conditions under which knowledge could be obtained, whether of God or the natural world. When, for instance, he turned to examples from natural philosophy to illustrate the mind's encounter with God, the resulting arguments were ambiguous. Let us consider a passage from the second half of *Things Above Reason* where Boyle, for the second time, compared the intellect's inability to grasp God's attributes with the imagination's inability to picture countless infinitesimally small atoms:

I see no necessity, That Intelligibility to a *humane Understanding*, should be necessary to the Truth or Existence of a thing; any more then that Visibility to a *Humane Eye*, should be necessary to the Existence of an Atome, or of a Corpuscle of Air, or of the *Effluvium's* of a Loadstone, or the Fragrant Exhalations of *Ambergris*, and Musk from a perfumed Glove [...].²³

As we saw at the very start of this essay, Boyle and his contemporaries frequently discussed the impossibility of experiencing or imagining imperceptibly small particles of matter. Indeed, they held up the imagination's inability to picture the enormous number of atoms making up even the smallest perceptible things as an appropriate analogue for the intellect's inability to grasp God's infinite perfections. In his *Cosmologia Sacra* (1701), for example, the botanist and physico-theologian Nehemiah Grew used the inconceivable divisibility of matter, infinite for all practical purposes, as an illustration of how 'deeply and far out of sight' God had hidden 'the Foundation of the Generations and Operations of Bodies'.²⁴ The comparison between atoms and God might therefore be cited as an expression of Boyle's radical voluntarism, with its emphasis on the impossibility of perceiving atoms interpreted as a reminder of the discrepancy between human reason and God's agency.²⁵

Boyle's own explanation, given a page later, gives us quite a different sense of his intentions. He clarifies his meaning by mobilising another comparison from the domain of philosophy, this time invoking geometry:

[...] there is no necessity that we should be interdicted all Knowledge of those sublime Objects, in which there are many things, whereof [...] we must confess our selves ignorant. Thus elder Geometricians knew very well what a

Rectangular Triangle was, when they conceived it to be a Figure consisting of three strait Lines, two of which comprize a right Angle; though probably for a great while they did not know so much as all its *chief Properties* or Affections [...].²⁶

Geometricians before Pythagoras knew exactly what a right-angled triangle was – a triangle with a 90-degree angle in one of its corners – even though they had not yet worked out that the square of the hypotenuse was equal to the sum of the squares of the remaining two sides. For Boyle, therefore, the history of geometry showed that accurate and useful knowledge of an object did not have to depend on a complete intellectual or imaginative grasp of all its properties. Extending this line of thought to the ‘sublime Objects’ of theology, Boyle hinted that knowledge of God was possible after all. The human faculties could obtain partial but nonetheless reliable knowledge of God’s attributes, even though it would never grasp them entirely. As Alan Chalmers has disapprovingly pointed out, moreover, Boyle asserted the value of such incomplete explanations when dealing more directly with the mechanical philosophy. In his essay ‘About the Excellency and Grounds of the Mechanical Hypothesis’ (1674), for instance, Boyle argued that hypotheses that failed to explain phenomena in terms of first principles could nevertheless provide the mind with partial insights that were both pleasing and useful.²⁷

Boyle gave several indications, moreover, that he thought it possible to make God himself into an object of sensory experience. Consider, for instance, his treatment of a thought experiment from the sixth of Descartes’s *Meditations*. Descartes began by pointing out that it was easy both to understand and to form a mental image of a three-sided figure: ‘not only do I understand it to be a shape enclosed by three lines, but at the same time, with the eye of the

mind, I contemplate the three lines as present, and this is what I call imagining'. Such was not the case, however, when it came to shapes with many more sides. It was easy enough to understand that a chiliogon was a figure with a thousand sides. It was evidently impossible, however, to form an accurate mental image of such a complex shape. 'I may perhaps picture some figure to myself in a confused fashion', Descartes explained, '[but] it is quite clear that this is not a chiliogon, because it is not at all different from the picture I would also form [...] if I were thinking about a myriogon, or some other many-sided figure'. In other words, the intellect could understand complex phenomena even when the imagination was incapable of picturing them. For Descartes, therefore, the contemplation of many-sided polygons served to demonstrate that there was a fundamental ontological distinction between the intellect and the imagination. The intellect was an immaterial entity that did not depend upon the bodily faculties of the mind – the senses and the imagination – for its existence.²⁸

As we saw earlier, Boyle had in fact embraced this distinction at another point in the text, mobilising it to attack Hobbes's argument for the impossibility of possessing intelligible ideas of God. At this point, however, he glossed over that crucial distinction, instead making an argument that depended on identifying similarities between the two faculties. He proposed to explain the immaterial intellect's encounter with God by likening it to the imagination's encounters with material things:

'Tis scarce possible to find very apposite examples, to illustrate things of a kind so abstruse and heteroclite as those may well be suppos'd, that do surpass our Reason. But yet some assistance may be borrowed from what we may observe in that other faculty of the mind, which is most of kin to the Intellect, I mean the *Imagination* [...].²⁹

Asserting the kinship between the intellect and the imagination enabled Boyle to put Descartes's demonstration of the weaknesses of the imagination to a new purpose. He agreed that the imagination stood no chance of forming a complete, intelligible image of a figure like the myriogon: the result would be nothing more than 'a confused *Idea* of a *Polygon* with a very great many sides'. Unlike Descartes, however, Boyle asserted that the imagination's inability to picture such an object could serve as an informative stand-in for the manner in which the intellect was overpowered in its reckoning with God.³⁰

All the way through *Things Above Reason*, Boyle used comparisons of the same kind to illustrate the mind's encounter with God. In several places, for instance, he compared that encounter to what happened when the eye had to reckon with objects that could not be distinctly seen. In one case, he used the image of a mariner catching sight of land for the first time. The mariner might not know exactly what type of land he would find when he got closer to the shore – whether it would turn out to be rocky or inhabited – but he could nevertheless be satisfied with the partial insight that it was land and not sea. At the same time, he likened the intellect's encounter with God to the eye's inability to grasp objects too large to be seen in one view. It was impossible, he noted in one of these comparisons, for the unaided eye to perceive the full extent of an ocean. As Boyle explained, however, no reasonable observer would count the eye's weakness as a good reason for denying that the rest of the ocean existed, and that it was truly a vast object. Instead, he pointed out that a sensible observer would realise that what he could see was merely a small part of something much larger – an enormous body of water 'which may, for ought he knows, reach to a vast extent beyond the visible Horizon'.³¹ As we can see, these comparisons had mixed meanings. On the one hand, they held up the imagination's inability to reckon with extremely large or distant objects as an illustration of the intellect's inability to reason about an infinite God. On the other hand, they undercut this message by signalling that

the imagination's encounters with some objects could serve as a model for grasping, if only in a partial sense, what God's attributes were like. The repeated appearance of such comparisons gives us a sense, therefore, that Boyle regarded the imagination and its objects in the world of perceptible, material finite things as informative analogues for the immaterial intellect's encounter with an infinite God.

We cannot therefore regard *Things Above Reason* as a straightforward expression of Boyle's belief in the radical contingency of the world and God's total inaccessibility to the material parts of the mind. His attempts to represent the mind's encounters with God instead opened a contradictory possibility – that the imagination could enable the intellect to obtain useful knowledge of God's nature and attributes. At times this possibility, latent in Boyle's comparisons, floated to the surface of his diffusely expressed argument. Consider for instance his summing up of the lessons to be drawn from the comparison between the imagination and the intellect:

So when we speak of Gods Primity (if I may so call it)[,] Omnipotence, and some other of his infinite Attributes and Perfections, we have some conceptions of the things we speak of, but may very well discern them to be but inadequate ones

Boyle did not claim here that the human faculties were totally incapable of reckoning with God. Rather, he qualified the argument he had been making up to that point with the proviso that the mind could possess 'some conceptions', however limited, of things above reason. He added this qualification, moreover, at several other points in the work. When discussing eternity, for example, he remarked that 'a considering person' could obtain a limited notion of infinite

duration by contemplating extremely long – but nevertheless finite – periods of time. In these moments, Boyle carefully distinguished his argument for the mind's inability to possess adequate ideas of an infinite God from the harsher alternative that it could possess no ideas at all. Instead of following Hobbes's assertion that the mind's encounter with God would result in complete and utter confusion, he suggested that the senses and imagination could somehow furnish the mind with ideas bearing some relation to the attributes of God.³²

We can now understand Boyle's case. His main aim was to resist the Socinian argument that revealed religion should be judged according to the strictures of human reason. For much of the work, he therefore sought to place God safely beyond the grasp of rational comprehension, mobilising the argument that there be no relation whatsoever between infinities and the finite objects of sensory (or even intellectual) experience. He subverted that argument, however, with his comparisons. Those comparisons opened an opposing possibility – that the finite objects to be found among the things that God had created could, after all, yield insights commensurate in some degree to the attributes of an infinite, immaterial God.³³ An explanation for the tension between these two positions might be found by putting Boyle's desire to secure sacred mysteries from the prying eyes of reason in a broader context. In *Final Causes*, as we have already seen, Boyle manifested an equally strong commitment to resisting the implication that natural philosophy could do nothing at all for theology. He did not want to concede Descartes's argument that experiments and observations could reveal nothing at all of God's attributes and purposes. It is therefore perhaps not entirely surprising that, even in his most concerted effort to delineate the limits of the human faculties, he held on to the notion that God could be an object of aesthetic experience – if only to a limited extent. In doing so, I would suggest, he kept open the possibility of using the practices of empiricism to gain theological knowledge, in spite of God's ultimate unintelligibility.

A Chemical Resurrection

Boyle's attempt to keep open a small space for physico-theology was not, however, a mere apologetic stratagem, deployed without regard to its consistency with his broader system of thought. We have already encountered evidence to suggest that he and his contemporaries identified important overlaps between the task of representing atoms and that of representing God. Recall that both Boyle and Grew held up the imagination's encounter with an almost infinitely large number of imperceptibly small atoms as an instructive analogue for the mind's encounter with God. It therefore makes sense to embark on a deeper inquiry into the possible connections between their strategies for bringing atoms into the realm of sensory experience and their attempts to do just the same thing with God.

It is true that in *Things Above Reason* Boyle used the impossibility of imagining atoms to illustrate the impossibility of completely grasping the attributes of God. His point, as we have seen, was that natural philosophers willing to accept the existence of inconceivable atoms should not turn up their noses at the possibility of an equally inconceivable God. It is abundantly clear, however, that he and his contemporaries did not admit the unintelligibility of atoms in order to exclude them from the realm of rational inquiry. Instead – as is well known – they claimed that observations on the objects of sensory experience could yield a partial but nonetheless highly probable kind of knowledge about the forms and motions of those particles.³⁴ Boyle and his contemporaries were, moreover, aware of the resulting paradox. As they understood it, the aim of the empirical project was to drag entities that could be neither perceived nor imagined into the realm of sensory experience. In the first of his *Three Physico-Theological Discourses* (1693), for instance, John Ray was moved to praise Boyle's chemical experiments for their strange ability to do just that. 'But for a sensible [perceptible] demonstration of the unconceivable, I had almost said infinite, divisibility of matter', he wrote, 'I might refer the Reader to the Honourable Mr. *Boyl* of famous memory his Discourse

concerning the strange subtlety of *effluvioms*'.³⁵ Here we can see a broad point of coherence between the natural-philosophical project of representing atoms and the physico-theological project of representing God. When Boyle likened God's infinite extent to finite objects such as the ocean or the coastline, he was mobilising the same basic assertion at work in natural philosophy – that objects of sensory experience could somehow stand in for entities that were, by their very definition, impossible to experience. To borrow Ray's powerful turn of phrase, we might therefore say that Boyle was attempting to give his readers a 'sensible demonstration' of God's 'unconceivable' attributes.

In other works, both theological and natural-philosophical, Boyle made much more explicit claims about the theological insights to be gained from representations of imperceptible particles. Perhaps the most striking – and least studied – of them all is *Some Physico-Theological Considerations about the Possibility of the Resurrection*. This short text appeared as an addition to *Some Considerations about The Reconcilableness of Reason and Religion* (1675), a much longer treatise that floated many of the same arguments that would receive a fuller airing some six years later *Things Above Reason*. Most works of physico-theology concerned themselves exclusively with natural religion, seeking only to demonstrate God's existence and activity in the world. By contrast, Boyle's *Possibility of the Resurrection* deals explicitly with a point of revealed religion – the promised re-composition of every human body at the end of time. The work therefore fell outside the mainstream, belonging to that speculative branch of physico-theology, exemplified by Ray's *Three Physico-Theological Discourses*, concerned with providential events that seemed to depend, at least in part, on physical causes – events such as the deluge and the earth's promised destruction at the end of time. Although the work was a little unusual, Boyle's polemical agenda was, as Salvatore Ricciardo has recently shown, a familiar one. His polemical targets in *Possibility of the Resurrection* were the same as the ones he would go on to tackle in *Things Above Reason*. He wanted to resist the notion that

revelation could be judged by exclusively rational means while at the same time demonstrating the theological utility of his own brand of atomistic natural philosophy.³⁶

In line with the first of these aims, Boyle framed his discussion as a response to those who rejected the promise of the resurrection because they regarded it as impossible. For Boyle, one of the strongest such objections to the possibility of the resurrection was that human bodies decompose after death, their matter being widely dispersed and finally incorporated into the bodies of other substances, plants and animals. God was therefore left with a seemingly insurmountable difficulty. To re-compose every human body that had ever lived, he would first need to extricate the immense number of ‘scattered parts’ that had once made them up from all the new substances to which they had been joined. After that, he still had the task of reconstituting all those particles ‘after the same manner wherein they existed’ before.³⁷ With the title *Possibility of the Resurrection*, Boyle made it clear that he would respond to this objection neither by seeking to describe exactly how the resurrection could take place, nor by attempting to prove that it could be explained in entirely natural terms. Instead, he carefully signalled his belief that so momentous an occurrence could only be regarded as an unintelligible effect of God’s absolute and unfettered wisdom, will and power. Admitting the ultimate incomprehensibility of the resurrection did not, however, lead him to make it a matter for faith alone. Instead, he argued that a limited kind of knowledge could still be obtained – not enough to explain how the resurrection would come about, but sufficient at least to disabuse those who rejected the doctrine because they regarded it as a complete impossibility. If natural philosophy could not explain the resurrection in detail, it could nevertheless produce a demonstration that the process was physically possible.³⁸

Here Boyle saw an opportunity to exploit the main explanatory resource of his corpuscular hypothesis – the claim that transformations in the perceptible qualities of material things were caused by changes in the composition and motions of imperceptible, semi-

permanent clusters of atoms called corpuscles. Using this framework, he could argue that the incorporation of one substance into another involved neither transformation nor destruction at the corpuscular level. The corpuscles making up human bodies remained present through the whole process, merely concealed by being temporarily arranged with those of other substances to produce different sensory effects. By way of example, he cited cases where sensory evidence seemed to indicate the continued presence of corpuscles that had been incorporated into other substances, noting for instance that the purple colour of juniper berries could be imparted to the flesh of pigs that fed on them.³⁹ Such examples, however, only represented half of the process presumed necessary. He needed a visible phenomenon capable of evidencing not just the persistence of corpuscles in other substances, but also the possibility that they could be recomposed just as they had been before.

Boyle found this phenomenon in a chemical experiment known as the ‘reduction to the pristine state’. A decade beforehand, he had made prominent use of a version of that experiment, involving camphor, in *The Origine of Formes and Qualities* (1666). In this text, he mobilised experimental observations both to attack scholastic theories of matter and to urge the acceptance of his mechanical, corpuscular hypothesis in their place. Boyle saw the camphor reduction as a decisively powerful piece of perceptible evidence both for the existence of his corpuscles, and for the mechanical quality of the interactions between them. To grasp the significance of Boyle’s use of the camphor reduction in his discussion of the resurrection, we must therefore first examine how he used it in *Formes and Qualities* to bring inconceivably small corpuscles into the realm of sensory experience.

To begin, Boyle took a quantity of camphor and mixed it with oil of vitriol (concentrated sulphuric acid) to produce an odourless, reddish solution. As he carefully explained, this solution had none of the original qualities that could be perceived in camphor – a white colour, strong smell and brittle texture. When he added water to the mixture, however, an exothermic

reaction took place. Shortly thereafter the camphor began to precipitate out of the solution and back into view:

if into this Liquor you pour a due quantity of fair Water, you will see (perhaps not without delight) that, in a trice, the Liquor will become pale, almost as at the first, and the Camphire, that lay conceal'd in the pores of the Menstruum, will immediately disclose it self, and emerge, in its own nature and pristine form of white floating and combustible Camphire, which will fill [...] the Air with its strong and Diffusive Odour.⁴⁰

Describing the experiment's outcome, Boyle carefully noted that the substance that emerged from the solution possessed exactly the same perceptible qualities – colour, texture, flammability and aroma – as the camphor had had at the start. As far as the human senses could discern, the reduction to the pristine state presented the disappearance and subsequent perfect reappearance of the substance. It is perhaps not hard to see why Boyle came to see this experiment, culminating in the instant recovery of a substance from apparent annihilation, as an analogue for the resurrection itself.

William R. Newman has shown that Boyle regarded the reduction to the pristine state as a particularly effective demonstration of the corpuscular hypothesis. For Boyle, the evident reappearance of camphor at the experiment's end made it reasonable to infer that the same substance had also been present when concealed from the senses through its mixture with sulphuric acid. The camphor reduction thus served as an empirical demonstration that a substance had persisted in an imperceptible state. With this demonstration, Boyle could in turn argue that all substances were composed of corpuscles – semi-permanent clusters of atoms so

small as to be imperceptible when disaggregated from one another and joined to those of other substances.⁴¹ At the same time, Boyle regarded the experiment as an empirical demonstration that those imperceptible corpuscles moved and interacted in a mechanical fashion. Consider, for instance, his reasoning about the physical causes of camphor's strong scent. For Boyle, the fact that the scent of camphor could be eliminated and subsequently restored by two odourless compounds – oil of vitriol and water – suggested that odour was not a real property of bodies. He proposed instead that it was an effect worked upon the senses by changes in the size, shape, motions and resulting texture of particles as they were placed mechanically into varying combinations. He established this point by means of a markedly anthropocentric strategy. Boyle had effected a complete transformation in the perceptible qualities of camphor, including of course its scent, through the simple mechanical act of mixing it with other substances. It seemed likely to him, therefore, that analogous mechanical processes were at play among the corpuscles themselves. He inferred the workings of an invisible mechanism from mechanical operations that he had himself performed.⁴²

Before returning to Boyle's use of the experiment in *Possibility of the Resurrection*, it is worth pausing for a while to reflect on how the camphor reduction worked as a strategy for bringing otherwise imperceptible entities into the field of sensory experience. The crucial point to make on this score is that the perceptible phenomena did not in fact provide direct evidence for the things they purportedly demonstrated. Boyle could hardly rely on direct observation to demonstrate that the interactions between imperceptible corpuscles took place in a mechanical fashion. Instead, he worked by assuming that phenomena accessible to the senses and imagination – in this case, his own experimental interventions – could stand in for and yield knowledge of the otherwise inconceivable processes going on at the microscopic level. Now, it is well known that Boyle favoured explanations based on the workings of visible phenomena that could be thought to work by mechanical means because he regarded them as more

intelligible than those offered by rival schools of thought. Indeed, he made a point of judging hypotheses about physical phenomena according to their intelligibility, admitting only those that could be readily grasped by the human faculties. In *Formes and Qualities* he dismissed scholastic explanations for chemical transformations by arguing that their unintelligibility made them worthless. His point was not just that the imagination would be forever unable to grasp the immaterial agents – known as ‘substantial forms’ – so important to scholastic theories of matter. Rather, he asserted that an unintelligible explanation was in fact no explanation at all, asking sarcastically asking how ‘Incomprehensible [...] substantial forms’ could ‘explain intelligibly This or That particular *Phaenomenon*?’ At the same time, he premised the superiority of his own explanations on the comparative ease with which the senses could grasp, and the imagination could picture, the workings of visible mechanical phenomena.⁴³

In line with her broader thesis, Wojcik interprets Boyle’s emphasis on the intelligibility of the mechanical hypothesis as an indication that he did not necessarily regard it as a truthful account of the world as God had created it.⁴⁴ It is of course true that Boyle understood the probabilistic knowledge resulting from experiments and observations to be provisional, and therefore apt to be modified or refuted in the future. It is also true, as we saw in *Things Above Reason*, that he believed God to be quite capable of constructing the world in a manner that did not match up either with what humans had discovered of it, or were capable of understanding.⁴⁵ Notwithstanding these admissions, Boyle nevertheless argued that natural philosophy could reveal real truths about God’s creation. A good example of this contradictory tendency is to be found in *Formes and Qualities* itself. Boyle opened the work by announcing his intention to frame a purely hypothetical account of how chemical transformations might be brought about. Soon, however, he changed his tone, repeatedly asserting that his micro-mechanical account of physical causation was in fact – in all likelihood – a true statement of how nature actually worked. When he got to the camphor reduction, he did not stop at identifying the corpuscular

hypothesis as an explanation of how changes in odour might conceivably be brought about. Instead, he bluntly stated that what the human nose understood as changes in odour were caused by changes in the ‘Texture’ of corpuscles when they came to be aggregated and disaggregated in differing combinations. By this stage, Boyle was asserting the truth of the corpuscular hypothesis, arguing that the world of imperceptible corpuscles actually operated according to the same principles observable in phenomena more readily accessible to sensory experience.⁴⁶

In *Possibility of the Resurrection*, by contrast, Boyle stuck to the more modest aim of obtaining a plausible account of how an occurrence like the resurrection might be brought about. He sought, as we have seen, only to establish that such an event was a possibility – that it did not run contrary to reason even though an exact or thorough explanation for its operations could never be obtained. As Boyle saw it, the way to accomplish this end was by showing not only that processes like the resurrection were to be found in the realm of sensory experience, but also that those processes were readily accessible to sensory experience. He therefore ran through several potential analogues for the resurrection, including experiments purporting to show the palingenesis of plants from their burnt ashes, before finally coming to a detailed account of the camphor reduction.⁴⁷ As in *Formes and Qualities*, Boyle once again held up the camphor reduction as a demonstration that substances were composed of infinitesimally small corpuscles, and that perceptible changes in their qualities were caused by mechanical alterations to the configuration of those corpuscles. The camphor’s reappearance at the experiment’s end was to be understood as the result of using water to mechanically separate the camphor corpuscles from those of sulphuric acid, and to return them to their original configuration.⁴⁸

Equipped with experimental evidence for a similar process, Boyle moved to establish the possibility of the resurrection itself. He proposed that God could – if he so chose – use a similar method to reconstitute each and every human body ahead of judgment day:

Since, I say, these things are so, why should it be impossible, that a most intelligent Agent [...] should be able so to order and watch the article of a Humane Body, as that *partly* of those that remain in the Bones, and *partly* of those that copiously flie away by insensible Transpiration, and *partly* of those that are otherwise disposed of upon their resolution, a competent number may be preserved or retrieved; so that stripping them of their disguises, or extricating them from other parts of Matter, to which they may happen to be conjoined, he may reunite them betwixt themselves, and, if need be, with particles of Matter fit to be contexted with them, and thereby restore or reproduce a Body , which, being united with the former Soul, may, in a sense consonant to the expressions of Scripture, recompose the same Man, whose Soul and Body were formerly disjoined by Death.⁴⁹

With these words, Boyle pictured the resurrection as a more complex version of the camphor reduction. He imagined God as a transcendently skilled chemist, reversing the decomposition of human bodies by extricating their corpuscles from the new substances into which they had been incorporated, and then reconstituting them in their original configurations. If a human could recover camphor from its apparent destruction through a series of simple mechanical interventions, then it stood to reason that a much wiser and more powerful agent could accomplish the same thing on a much grander scale.⁵⁰

Boyle made the resurrection into a partial object of knowledge, using a strategy entirely consistent with his approach to the representation of imperceptible particles. In each case, he asserted that objects accessible to sensory experience could be made to stand in for entities that

would otherwise remain inconceivable. He thus asserted that comparisons between imperceptible entities and the objects of sensory experience were both possible, and capable of yielding reliable insights. Boyle's interpretation of the physical causes of the camphor reduction depended, after all, on a presumption of ontological similarity not only between perceptible and imperceptible phenomena, but also between his own experimental interventions and the processes he believed to be going on at the corpuscular level. Although Boyle sought a lower grade of certainty when it came to the resurrection, he nevertheless used the same strategy to make it into an object of knowledge. The only difference was that he extended the ontological scope of the comparison even further, applying it not only to the experiment's physical causes, but also to the processes involved with the resurrection itself. The entire premise of his argument was that the imperceptible physical processes supposedly revealed by the experiment could be made to somehow stand in for – and yield knowledge of – the supernatural, unintelligible event promised in the Bible. Boyle's outwardly modest claim to be demonstrating nothing more than the possibility of the resurrection therefore concealed a remarkably ambitious attempt to demonstrate the theological potential of experimental natural philosophy.

Conclusions: Metaphysics, Theology and Representation

In the *Critique of Pure Reason* (1781), Immanuel Kant argued that the human mind was incapable of gaining knowledge about the metaphysical status of things external to it. As Kant saw it, the mind's reasoning about things was necessarily a function of its relation to those things. The mind could therefore gain access to things as they exist *for us*, but was left incapable of finding much out about things as they exist *for themselves*. It was this line of thought that led him to regard metaphysical and theological questions as matters for belief rather than knowledge. For Kant, the sciences could produce few answers to metaphysical questions

because there was simply no way to escape the relational quality of the mind's reasoning.⁵¹ Perhaps the strangest consequence of focusing excessively on Boyle's voluntarism is that it makes his attitude to the boundaries between knowledge and belief look very much like Kant's characteristically modern position. On Wojcik's reading, Boyle's belief in a world contingent on God's arbitrary will led him to abandon the possibility of using natural philosophy to obtain true knowledge about its ultimate causes. Long before the philosophical revolutions of Hume and Kant, you might say, Boyle's religious beliefs led him, perversely, to adopt a more or less modern outlook on the role of the sciences in relation to metaphysics and theology.

Boyle's representational practices, however, reveal a different picture. He used a comparative strategy to make unimaginable entities conceivable, dragging them from the realm of imperceptible entities into the realm of things accessible to sensory experience. Such an approach was at odds with his own belief in a world made thoroughly inaccessible to the human faculties by its dependence on God's arbitrary will and unlimited power. Instead, his comparisons bespeak a world in which there was continuity between God, human faculties, and the rest of creation – a world in which phenomena accessible to the senses could stand in for, and reliably lead to knowledge of, the inconceivable entities beyond them. In the preface to one of his last-published works, *The Christian Virtuoso* (1690), Boyle came close to making this point explicit:

Apposite Comparisons do not only give Light, but Strength, to the Passages they belong to, since they are not always bare Pictures and Resemblances, but a kind of Arguments; being oftentimes, if I may so call them, Analogous Instances, which do declare the Nature, or Way of Operating, of the Thing they relate to,

and by that means do in a sort prove, that, as 'tis possible, so it is not improbable, that the Thing may be such as 'tis represented.⁵²

To readers of the seventeenth century, comparisons were generally seen as figures of rhetoric, appropriate to poetry and persuasive forms of speech, but out of place when the circumstances called for philosophical precision.⁵³ Justifying his frequent use of comparisons in precisely such circumstances, Boyle turned to the same logic behind his use of the camphor reduction to establish the possibility of the resurrection. A well-chosen comparison could, he suggested, do the work of a philosophical analogy, helping not only to produce a powerful image but also to explain the phenomenon in question. Boyle thus positioned the comparison as an instrument for making the wisdom of God accessible to the imagination. To demonstrate the possibility that an unknown phenomenon acted in a certain manner, it was necessary only to find a similar process that could be represented in terms more readily accessible to sensory experience and its corollaries in the imagination.⁵⁴

None of this is to deny that Boyle's radical voluntarism put him at odds with contemporaries who also pursued physico-theology. It is safe to say that both Nehemiah Grew and John Ray, for instance, held slightly more 'intellectualist' positions, regarding the world more as an emanation of God's reason, and therefore more open to the human faculties. As Scott Mandelbrote has noted, both Ray and Grew were far more comfortable than Boyle with the idea that the study of nature could reveal the wisdom of God. Works such as Ray's *The Wisdom of God Manifested in the Works of Creation* (1691) and Grew's *Cosmologia Sacra* thus eschew Boyle's emphasis on God's unlimited power and freedom of will in favour of an emphasis on the world's orderliness and intelligibility.⁵⁵ One result of this emphasis on God's reason, as Peter Harrison has shown, was that Grew adopted a markedly different position on

the relationship between miracles and the laws of nature. He could not accept Boyle's suggestion that God was free simply to suspend the laws of nature to make miracles happen. Instead, he took the view that occurrences such as the plagues inflicted on Egypt to encourage the Pharaoh to release his Israelite captives were brought about by extremely long chains of natural causes, implanted in the world by God at the beginning of time and scheduled to coincide with moments when humanity had need of a divine message.⁵⁶

Despite such differences, however, the three naturalists used strikingly similar strategies – and similar ontological assumptions – when it came to imperceptible entities. Drawing on his earlier work dealing with the saline chemistry of plants, for instance, Grew argued in his *Cosmologia Sacra* that the order of the atomic world could be safely inferred from the order so readily apparent to him in perceptible phenomena. Immediately afterwards, however, he used a similar argument to show that God was responsible for creating that order:

Now Regularity, which is certain; cannot depend upon Chance, which is Uncertain. For that were to make Uncertainty, the Cause of Certainty. [...] It is therefore evident, That as Matter and Motion; so the Sizes [sic.] and figures, of the Parts of Matter, have their Original from a Divine Regulator.

Let us spell out exactly what Grew was suggesting here. It was not merely that the behaviour of imperceptible-but-material atoms could be inferred from the behaviour of material things open to the senses. Rather it was that the same phenomena could also shine a light on the attributes and intentions of an imperceptible, immaterial, and infinite God. This was a position, moreover, that Ray anticipated in a letter that he wrote in 1685 to Tancred Robinson, wherein he similarly argued that the regularity observable in visible saline particles was a compelling

argument for regularity among atoms. Both Grew and Ray assumed, therefore, that things accessible to the senses and imagination could stand in for imperceptible entities of uncertain ontological status. Like Boyle, they assumed that there was enough continuity between the perceptible and imperceptible parts of the world – including the human faculties and the mind of God – for the world of experience to stand in for the wisdom of God.⁵⁷

Today's distinctions between the realms of belief and knowledge are an impediment to understanding the connections between theology and natural philosophy at the end of the seventeenth century. No doubt, Boyle's efforts to determine how far the mind could apprehend unintelligible entities show us that he was interested in identifying the boundaries between them. Yet the epistemological categories of belief and knowledge did not, for him, match up squarely with the disciplinary categories of theology and natural philosophy. Despite his radical voluntarism, Boyle thought it possible not only to gain a limited kind of knowledge about God's attributes and intentions, but also to accomplish this task using the representational and investigative strategies of empirical natural philosophy. Shifting our analytical focus away from explicit statements of belief is therefore neither to deny nor diminish the importance of religious ideas and practices in natural philosophy. Rather, it is to recognise that much of the religious 'content' of Boyle's thought is to be found in not only in statements of what he believed, but also in the practices through which he made things accessible to the organs of sensory and imaginative experience.

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For their help in preparing the article, I am grateful to Cécile Bishop, Danielle Carr, Michael Hunter, Joanna Picciotto, Courtney Weiss-Smith, and the anonymous reviewers. I presented the first iteration of this article at the ‘Depicting the Invisible’ workshop organised by Jenny Rampling at Princeton University (12-13 February 2016). I am thankful to Jenny for the opportunity to present my work at that excellent event, and to all the participants for their valuable thoughts. I would also like to thank Charlotte Sleigh and Trish Hatton for their excellent work in bringing this article to press. Finally, I am delighted to acknowledge the Leverhulme Trust and the Department of History at University College London for supporting my research.

¹ Robert Boyle, *A Discourse of Things Above Reason. Inquiring Whether a Philosopher should admit there are any such*, London, 1681, in Michael Hunter and Edward B. Davis (eds.), *The Works of Robert Boyle*, 14 vols., London: Pickering and Chatto, 1999-2000, vol. 9, p. 377.

² Boyle, op. cit. (1), p. 367.

³ Scott Mandelbrote, ‘The Uses of Natural Theology in Seventeenth-Century England’, *Science in Context* (2007) 20:3, pp. 451-480, 459, 473.

⁴ Rhodri Lewis, *William Petty on the Order of Nature: An Unpublished Manuscript Treatise*, *Medieval and Renaissance Texts and Studies* 399, Tempe, AZ: Arizona Center for Medieval and Renaissance Studies, 2012, 31. See also Brian W. Ogilvie, ‘Insects in John Ray’s Natural History and Natural Theology’, in Karl A.E. Enekel and Paul J. Smith (eds.), *Zoology in Early Modern Culture: Intersections of Science, Theology, Philology, and Political and Religious Education*, *Intersections: Interdisciplinary Studies in Early Modern Culture* 32, 2014, pp. 235-262, 257,

⁵ Jonathan Sheehan, ‘Thomas Hobbes, D.D.: Theology, Orthodoxy, and History’, *The Journal of Modern History* (2016) 88, pp. 249-274, 260-1. See also Peter Harrison, *The Territories of Science and Religion*, Chicago: University of Chicago Press, 2015, especially Ch. 4, ‘Science and the Origins of “Religion”’, pp. 83-116.

⁶ Quentin Meillassoux, *After Finitude: An Essay on the Necessity of Contingency* (tr. Ray Brassier), London: Bloomsbury, 2012, pp. 1-9. First published in French as *Après la finitude*, Paris: Editions du Seuil, 2006.

⁷ Willis’s work as originally published in Latin as Thomas Willis, *Cerebri Anatome: cui Accessit Nervorum Descriptio et Usus*, London, 1664. The work was published in English as part of Thomas Willis, *Dr. Willis’s Practice of Physick, Being the whole Works of that Renowned and Famous Physician*, (tr. Samuel Pordage), London, 1684. The part corresponding to the *Cerebri Anatome* is entitled *The Anatomy of the Brain*, and has its own pagination. Henceforth it will be referred to as Willis, *Anatomy of the Brain*. For Willis’s account of the imagination, see Willis, *Anatomy of the Brain*, pp. 46, 75-9, 87. For Descartes’s account of sensation, imagination and memory, see René Descartes, *The World and Other Writings* (ed. Stephen Gaukroger), Cambridge Texts in the History of Philosophy, Cambridge: Cambridge University Press, 1998, pp. 146-9. On Boyle’s broad agreement with such physiological accounts of the generation of ideas – if not their precise details – see J. J. MacIntosh, ‘Perception and Imagination in Descartes, Boyle and Hooke’, *Canadian Journal of Philosophy* (1983) 13:3, pp. 327-352, 334.

⁸ Thomas Hobbes, *Leviathan* (ed. Richard Tuck), Cambridge Texts in the History of Political Thought, Cambridge: Cambridge University Press, Revised Student Edition, 1996, Ch. 3, p. 23. See also Ch. 31, p. 250.

⁹ René Descartes, *Meditations on First Philosophy with Selections from the Objections and Replies* (tr. Michael Moriarty), Oxford: Oxford University Press, 2008. Descartes’s curt

dismissal of physico-theology comes in the fourth of the *Meditations*, p. 40. In his replies to Pierre Gassendi's objections to the *Meditations*, he gave a more extended account of his thoughts. See pp. 191-3, especially 193. For discussions of Descartes's rejection of physico-theology, see also Matthew L. Jones, *The Good Life in the Scientific Revolution: Descartes, Pascal, Leibniz, and the Cultivation of Virtue*, Chicago: University of Chicago Press, 2006, p. 227, and Margaret J. Osler, 'From Immanent Natures to Nature as Artifice: The Reinterpretation of Final Causes in Seventeenth-Century Natural Philosophy', *The Monist* (1996) 79:3, pp. 388-407, 392-93.

¹⁰ This text was first published in Latin as Thomas Willis, *De Anima Brutorum*, Oxford, 1672. Like the *Cerebri Anatome*, it was published in English as part of Willis, *Dr. Willis's Practice of Physick*, op. cit. (7). *De Anima Brutorum* appeared in this edition, with separate pagination, as Thomas Willis, *Two Discourses Concerning the Soul of Brutes*. For Willis's remarks on the immortal soul, see Willis, *Soul of Brutes*, p. 39.

¹¹ Boyle, op. cit. (1), p. 415. See also Robert Boyle, *The Christian Virtuoso* (London, 1690-1), in Boyle, *Works*, vol. 11, p. 285. 'As if, because Rational Spirits are Invisible and Immaterial Beings, all Disquisitions about them must be airy and uncertain Speculations, and, like their Objects, devoid of Solidity and Usefulness. But though among these Ingenious Men there are several, whose Expectations from me I am much more disposed to Gratify, than Disappoint; yet, on such an occasion as this, I must take the liberty to own, That I do not think the Corporeal World, nor the Present State of Things, the Only or the Principal Subjects, than an Inquisitive Man's Pen may be worthily employed about'. On Boyle's agreement with Descartes on the limits of the imagination and the possibility of possessing immaterial ideas or intuitions, see MacIntosh, op. cit. (7), pp. 328, 342.

¹² Robert Boyle, *A Disquisition about the Final Causes of Natural Things* (London, 1688), in Boyle, *Works*, vol. 11, pp. 92-3, p. 118. For a more direct statement, see Boyle, op. cit. (11),

p. 297. Boyle engaged closely with Descartes's thought, enlisting the help of Robert Hooke. See Edward B. Davis, 'Parcere Nominibus': Boyle, Hooke and the rhetorical interpretation of Descartes', in Michael Hunter (ed.), *Robert Boyle Reconsidered*, Cambridge: Cambridge University Press, 1994, pp. 157 – 175.

¹³ Michael Hunter, 'Casuistry in Action: Robert Boyle's Confessional Interviews with Gilbert Burnet and Edward Stillingfleet, 1691', *Journal of Ecclesiastical History* (1993) 44:1, pp. 80-98, and Michael Hunter, 'The Disquieted Mind in Casuistry and Natural Philosophy: Boyle and Thomas Barlow', in Michael Hunter, *Boyle Studies: Aspects of the Life and Thought of Robert Boyle (1627-91)*, Farnham: Ashgate, 2015, pp. 107-129.

¹⁴ Boyle, op. cit. (1), pp. 366-367, 404.

¹⁵ Boyle, op. cit. (1), pp. 367-69.

¹⁶ Jan W. Wojcik, *Robert Boyle and the Limits of Reason*, Cambridge: Cambridge University Press, 1997, pp. 44-58. On the – often subtle – influence of Socinianism among natural philosophers in the latter part of the 17th century, see William Poole, 'Francis Lodwick's Creation: Theology and Natural Philosophy in the Early Royal Society', *Journal of the History of Ideas* (2005) 66:2, pp. 245-263, especially p. 259. On the English reception of Socinian thought in the first half of the century, see Sarah Mortimer, *Reason and Religion in the English Revolution: The Challenge of Socinianism*, Cambridge Studies in Early Modern British History, Cambridge: Cambridge University Press, 2010.

¹⁷ Wojcik, op. cit. (16), pp. 86-97.

¹⁸ Wojcik, op. cit. (16), pp. 106-8, 114-16.

¹⁹ Wojcik, op. cit. (16), p. 7.

²⁰ On Boyle's approach to miracles, see Peter Harrison, 'Newtonian Science, Miracles, and the Laws of Nature', *Journal of the History of Ideas* (1995) 56:4, pp. 531-553, 535. On the importance of theological voluntarism to the emergence of empiricism see Margaret J. Osler,

‘Mixing Metaphors: Science and Religion or Natural Philosophy and Theology in Early Modern Europe’, *History of Science* (1997) 35, pp. 91-113, 104-106. On the role of voluntarism in Boyle’s thought in particular, see Margaret J. Osler, ‘The Intellectual Sources of Robert Boyle’s philosophy of nature: Gassendi’s voluntarism and Boyle’s physico-theological project’, in Richard W. F. Kroll, Richard Ashcraft, and Perez Zagorin (eds.), *Philosophy, science, and religion in England, 1640 – 1700*, Cambridge: Cambridge University Press, 1992, pp. 178 – 198, especially pp. 185-7.

Neither the term ‘voluntarism’ nor its antonym ‘intellectualism’ were in fact used during the seventeenth century to describe theological positions. Peter Harrison has thus questioned the tendency to classify natural philosophers such as Descartes and Boyle as either voluntarists or intellectualists, noting a good deal of fluidity and inconsistency in their positions. See Peter Harrison, ‘Voluntarism and Early Modern Science’, *History of Science* (2002) 40, pp. 63-89. Harrison’s intervention led John Henry to respond by reasserting the value of the terms, seeking to remind Harrison that the theological distinction between voluntarists and intellectualists corresponded to the distinction between empiricists and rationalists in natural philosophy. See John Henry, ‘Voluntarist Theology at the Origins of Modern Science: A Response to Peter Harrison’, *History of Science* (2009) 47, pp. 79-113.

²¹ Wojcik, op. cit. (16), pp. 206-9.

²² Wojcik, op. cit. (16) pp. 168-204.

²³ Boyle, op. cit. (1), pp. 398-99. See also p. 377 as cited above.

²⁴ Nehemiah Grew, *Cosmologia Sacra: or a Discourse of the UNIVERSE as it is the Creature and Kingdom of GOD* (London, 1701), p. 12. On the preceding page Grew defines infinite divisibility not in absolute terms but rather in relation to human capacities. See p.11, ‘For as far as the Whole is Extensible, so far the Parts are also Divisible, both Indefinitely; or as Mathematicians speak, Infinitely: that is, beyond any Human Observation or Conception.’

²⁵ The passage is, for instance, given this interpretation by Lawrence M. Principe. See Lawrence M. Principe, *The Aspiring Adept: Robert Boyle and his Alchemical Quest*, Princeton: Princeton University Press, 1998, p. 194. I regard this reading not as incorrect but rather as incomplete. It gives us an accurate account of one part of Boyle's intended meaning, but not the whole.

²⁶ Boyle, op. cit. (1), p. 399.

²⁷ Alan Chalmers, 'The Lack of Excellency of Boyle's Mechanical Philosophy', *Studies in History and Philosophy of Science* (1993) 24:4, pp. 541-564, 556-8.

²⁸ Descartes, op. cit. (9), pp. 51-2. J. J. MacIntosh offers another interpretation of Boyle's treatment of Descartes's polygon example, stressing points of agreement between the two philosophers. See MacIntosh, op. cit. (7), p. 342.

²⁹ Boyle, op. cit. (1), p. 377.

³⁰ Boyle, op. cit. (1), p. 377.

³¹ Boyle, op. cit. (1), pp. 384-85. Other comparisons to the capacities to the eye are to be found pp. 380, 382-83, 386, 398-99, 401, 412, 415-16, 420. In addition, Boyle mobilised similar comparisons referring to the capacities of the imagination. Excluding the above-cited comparison involving many-sided polygons, these are to be found pp. 385, 403, 420 (part of the same example cited in the list of 'eye' comparisons in this footnote).

³² Boyle, op. cit. (1), pp. 377-78. Boyle again indicated that finite quantities imaginable to humans could be used to give an inadequate account of God's infinite perfections later in the work. See p. 389.

³³ Boyle made this claim even though he was aware that, properly speaking, there could be no ratio between a finite quantity and an infinite quantity. See Boyle, op. cit. (1), p. 390. Boyle would also have been familiar with the argument from his engagement with Descartes's critique of physico-theology.

³⁴ Grew, op. cit. (24), p. 11.

³⁵ John Ray, *Three Physico-Theological Discourses*, London, 1693, p. 52.

³⁶ Salvatore Ricciardo, 'Robert Boyle on God's "experiments": Resurrection, immortality and mechanical philosophy', *Intellectual History Review* (2015) 25:1, pp. 97-113, 101-102.

³⁷ Robert Boyle, *Some Physico-Theological Considerations about the Possibility of the Resurrection*, London, 1675, in Boyle, *Works*, vol. 8, pp. 303-304. For Boyle, the other most pressing objection was the problem of identity. His account of the resurrection depended on demonstrating that the human body does not always consist of the same particles of matter throughout its entire life. Making this case enabled him to propose that God could bring the resurrection about using any particles of matter he saw fit. He thus needed to demonstrate that, in spite of the changes in its material composition, the identity of the being inhabiting that body would remain the same. See Fernando Vidal, 'Brains, Bodies, Selves, and Science: Anthropologies of Identity and the Resurrection of the Body', *Critical Inquiry* (2002) 28: 4, 930 – 974, pp. 952-56.

³⁸ Boyle, op. cit. (37), pp. 299-300, 309.

³⁹ Boyle, op. cit. (37), p. 306.

⁴⁰ Robert Boyle, *The Origine of Formes and Qualities*, London, 1666, in Boyle, *Works*, vol. 5. p. 395.

⁴¹ William R. Newman, *Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution*, Chicago: University of Chicago Press, 2006, pp. 158-9, 190-215.

⁴² For a general discussion of Boyle's use of this kind of inference, see Newman, op. cit. (41), pp. 188-189.

⁴³ Boyle, op. cit. (40), p. 352.

⁴⁴ Wojcik, op. cit. (16), pp. 167-179, especially p. 179.

⁴⁵ It is worth mentioning that, as Daniel Garber has shown, Descartes eventually concluded that natural philosophy was incapable of yielding certainty about how the world had been put together. In the *Principia Philosophiae* he hinted that God could have created the universe in any number of different, but equally plausible, ways. Thus the natural philosopher could only hold up explanations as plausible explanations for how natural phenomena might function – not as accounts of how they actually functioned. See Daniel Garber, *Reading Cartesian Philosophy through Cartesian Science*, Cambridge: Cambridge University Press, 2001, pp. 121-8, especially pp. 125-6, 128.

⁴⁶ Boyle, op. cit. (40). C.f. his remarks in the preface, p. 302, with pp. 355, 396-7. Boyle blurred the lines between plausible hypotheses and matters of fact on other occasions. Consider, for instance, his attempts to persuade contemporaries that the ‘spring of the air’ was an observable fact, rather than a mere hypothesis. See Steven Shapin and Simon Schaffer, *Leviathan and the Air-pump: Hobbes, Boyle, and the Experimental Life*, Princeton: Princeton University Press, 1985, pp. 50, 213.

⁴⁷ For Boyle’s discussion of palingenesis experiments, see Boyle, op. cit. (37), p. 303. Michael Hunter has shown that there are significant overlaps between *Possibility of the Resurrection* and Boyle’s earlier ‘Essay of the Holy Scriptures’. Ricciardo has shown, however, that discussions of palingenesis play a much larger role in the earlier text than they do in the version of *Possibility of the Resurrection* published by Boyle in 1675. See Michael Hunter, *Robert Boyle, 1627-91: Scrupulosity and Science*, Woodbridge: The Boydell Press, 2000, p. 32 and Ricciardo, op. cit. (36), p. 106.

⁴⁸ Boyle, op. cit. (37), pp. 307-8.

⁴⁹ Boyle, op. cit. (37), p. 311.

⁵⁰ Boyle, op. cit. (37), pp. 310-311.

⁵¹ Meillassoux, op. cit. (6), pp. 3-4.

⁵² Boyle, *op. cit.* (11), p. 287. Lotte Mulligan has also noted that Boyle's remarks here seem to bespeak a metaphysical argument as well as an approach to making things accessible to the imagination. See Lotte Mulligan, 'Robert Boyle, "Right Reason," and the Meaning of Metaphor' *Journal of the History of Ideas* (1994) 55:2, pp. 235-257, 254-55.

⁵³ On the ambiguous place of the comparison in early modern natural philosophy, see Peter Galison, 'Descartes's Comparisons: From the Invisible to the Visible', *Isis* (1984) 75:2, pp. 311-326, especially p. 323, and Jones, *op. cit.* (9), pp. 71-75.

⁵⁴ In this passage, Boyle indicated that the imagination – understood as the faculty responsible for presenting the mind with images derived from sensory experience – could play a role in the production of hypotheses in natural philosophy. At the same time, however, he acknowledged that the imagination was widely associated with poetic and rhetorical strategies for provoking vivid and pleasurable mental images. Elsewhere, I have shown that Boyle and his contemporaries made extensive use of comparisons in their descriptive works, seeking to associate the pleasures of the imagination with the production of knowledge. See Alexander Wragge-Morley, 'Vividness in English Natural History and Anatomy, 1650-1700', *Notes and Records of the Royal Society* (2012) 66:4, pp. 341-356. For a more expansive account of the role of the imagination in early modern natural philosophy, see Ofer Gal and Raz Chen-Morris, *Baroque Science*, Chicago: University of Chicago Press, 2013, pp. 233-282. See also Frédérique Aït-Touati, *Fictions of the Cosmos: Science and Literature in the Seventeenth Century*, Chicago: University of Chicago Press, 2011, especially pp. 79-94.

⁵⁵ Mandelbrote, *op. cit.* (3), p. 468.

⁵⁶ For Grew's position, see Harrison, *op. cit.* (20), pp. 540-41. Ray's position on miracles and portents fell somewhere between those of Grew and Boyle. In his discussion of the earthquake that took place in Jamaica in 1692, he indicated that such occurrences involved

natural causes. On the other hand, however, he suggested that God's special intervention was required to make them happen at the right moment. See Ray, *op. cit.* (35), p. 208.

⁵⁷ Grew, *op. cit.* (24), p. 17, and John Ray to Tancred Robinson, 12th May 1685, in William Derham (ed.), *Philosophical Letters between the Late Learned John Ray and several of his Ingenious Correspondents*, London, 1718, pp. 183-85, especially p. 185.