

Are Corpuscles Unobservable in Principle for Locke?

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ARE CORPUSCLES UNOBSERVABLE in principle for Locke? In this paper, I argue that the answer is no.¹ The question may seem small, but there has been a great deal of disagreement in the literature about it. Despite some controversy, the question has never been explicitly addressed in much detail. In this paper, I aim to resolve this controversy. Along the way, I hope to demonstrate that the issue of the observability of corpuscles is *not* a peripheral question about Locke's scientific views. Locke's philosophy, as I will argue, is seriously undermined by the assumption of a principled divide between unobservable corpuscles on the one side and observable ordinary objects on the other. Locke is committed to no such division; in Locke's view there is no reason, *in principle*, why we might not someday observe corpuscles.

The title question, of course, has only arisen since it has become a commonplace of Locke-interpretation that Locke was a corpuscularian. That is, Locke, in common with the most prominent natural philosophers of his day, held that physical phenomena are caused by the mechanical interactions of tiny particles which are characterizable in terms of a small number of "primary" qualities. In this he was particularly influenced by the corpuscular theories of Robert Boyle. The central tenet of Boylean corpuscularianism is roughly that all physical things are made up of tiny hard bodies of a certain size and shape. The macroscopic qualities of bodies are held to arise from these qualities of individual corpuscles,² plus their arrangements and motions. It is nowadays

¹ So, they *are* observable in principle. Since, following Locke and his commentators, I concern myself especially with visual perception in what follows, in effect I argue for the stronger conclusion that corpuscles were *visually* observable in principle for Locke.

² Boyle at different times uses the word 'corpuscle' in two different, closely related, senses. 'Corpuscle' may either denote one of the smallest physically undivided particles, the *minima naturalia*, or a small, stable complex of them. On this see Peter Alexander, *Ideas, Qualities, and Corpuscles* (Cambridge University Press, 1985), 66. In what follows, I take note of this ambiguity

rightly uncontroversial to assert that important aspects of Locke's philosophy (for example, his primary/secondary quality distinction and his conception of real essences) cannot be fully understood without taking note of Locke's corpuscularianism; no sharp distinction between Locke's philosophy and his natural philosophy is possible or helpful.³

Maurice Mandelbaum, whose influential essay "Locke's Realism" contributed much to this trend in Locke scholarship, holds that corpuscles have to be in principle unobservable for Locke.⁴ Peter Alexander, who centers his detailed interpretation of Locke upon Locke's corpuscularianism, argues for the same position, although his reasoning is unrelated to Mandelbaum's.⁵ Yolton⁶ and Buchdahl⁷ take the opposing view. Woolhouse recognizes this as an issue, and explicitly remains neutral.⁸

This question has also, naturally enough, troubled recent Berkeley scholars concerned with Berkeley's relationship to Locke and Berkeley's attitude towards corpuscularian scientific theories. R. J. Brook⁹ argues that corpuscles must be in principle unobservable; Daniel Garber¹⁰ assumes that Locke believed corpuscles to be observable in principle.

Most of Locke's interpreters who take my side of the dispute argue primarily from "microscopical eyes" passages (e.g., 2.23.11 and 12)¹¹ that Locke must have believed corpuscles to be observable in principle. Although such passages are, of course, relevant (and I shall cite and employ them in a certain context), they are not entirely conclusive, and the main point of this paper is to take another tack. I want to distinguish two questions, which need to be addressed separately:

only where relevant. I contend that in *neither* sense of 'corpuscle' were corpuscles unobservable in principle for Locke.

³ This is not, however, to claim that Locke's purpose in the *Essay* is to give a philosophical justification of corpuscular mechanism. Margaret Atherton takes issue with the latter claim in her recent paper, "Corpuscles, Mechanism and Essentialism in Berkeley and Locke," *Journal of the History of Philosophy* 29 (1991): 47–67.

⁴ In *Philosophy, Science, and Sense Perception* (Baltimore: Johns Hopkins Press, 1964), 15–18.

⁵ *Ideas, Qualities, and Corpuscles*, 183–88.

⁶ John W. Yolton, *Locke and the Compass of Human Understanding* (Cambridge University Press, 1970), 45–49.

⁷ Gerd Buchdahl, *Metaphysics and the Philosophy of Science* (Boston: MIT Press, 1969), 210–11.

⁸ R. S. Woolhouse, *Locke's Philosophy of Science and Knowledge* (New York: Barnes and Noble, 1971), 112.

⁹ *Berkeley's Philosophy of Science* (The Hague: Martinus Nijhoff, 1973), 94.

¹⁰ "Locke, Berkeley, and Corpuscular Scepticism," in *Berkeley: Critical and Interpretive Essays*, ed. Colin Turbayne (Minneapolis: University of Minnesota Press, 1982), 177.

¹¹ All references to Locke are to *An Essay concerning Human Understanding*, ed. Peter H. Nidditch (Oxford University Press, 1975) and are given by book, chapter, and section numbers.

- (1) Did Locke *think* that corpuscles were unobservable in principle?
 (2) Is there some Lockean principle which *dictates* that corpuscles cannot possibly be observed?

The second question arises because, if the claim that corpuscles are *in principle* unobservable is *justified*, Locke's philosophy must provide some relevant *principle*, the reason why they cannot possibly be observed. The two questions are logically independent, although not unrelated. Obviously, if Locke did think that corpuscles were unobservable in principle, there is more motivation to search for an appropriate Lockean principle. On the other hand, if no such principle is available, that counts as a strong reason against attributing to Locke a belief in the unobservability in principle of corpuscles, other things being equal. In the end, I answer *both* questions in the negative.

The paper is divided into three sections. In the first, I briefly isolate the sort of unobservability with which I am concerned here. In the second, I address the first of the two questions distinguished above. I argue that the evidence that Locke *believed* corpuscles were unobservable in principle is not compelling. I argue further that there is strong evidence for the positive thesis that Locke believed that corpuscles were in principle observable. Some of the ground I cover here is familiar, but the emphasis is new.

In the third section, I turn to the second of the two questions distinguished above, a question that has not before been explicitly raised in the literature, so far as I know. I examine Mandelbaum's, Brook's, and Alexander's arguments in order to determine the supposed Lockean principles behind their claims that corpuscles must be unobservable for Locke. I find that all three authors base their claims on principles which do indeed imply that corpuscles cannot possibly be observed. I argue, however, that the relevant principles lead to some very un-Lockean conclusions, and that these principles can and should be rejected. Although perhaps no single argument could conclusively demonstrate that corpuscles must be in principle observable for Locke (since there might be many different purportedly Lockean principles from which to argue for unobservability), I shall provide systematic considerations which establish that claims of unobservability cannot be based on reasons of the kind that Mandelbaum, Brook, and Alexander have in mind. As far as I am aware, no other arguments supplying Lockean reasons for unobservability have been given in the literature.¹²

¹² I am also of the opinion that Mandelbaum and Brook on one side and Alexander on the other exemplify the only two kinds of considerations which naturally come to mind, in the context of Locke-interpretation, as appropriately principled bases for in-principle unobservability. It seems to me that other authors (to be noted later) sympathetic to in-principle unobservability hint at considerations of one of those two kinds.

1.

In this paper, I do not take any stand on controversies about the limits (or lack thereof) of what counts as observation. For my purposes here, I assume that anything that is potentially viewable under some kind of microscope (whether a simple optical microscope or some advanced analogue) counts as observable in principle.

Of course, it could go without saying that Locke (and all other corpuscularians) held that corpuscles are too small for us to perceive directly, that they are "Bodies, each whereof is so small, that we cannot, by any of our Senses, discover either their bulk, figure, or motion" (2.8.13). Although microscopy was in rapid development at the time, there were no microscopes that could see bodies nearly so minute as corpuscles were supposed to be. So it is indisputable that Locke believed corpuscles to be *in fact* not observed. This is, of course, no in-principle unobservability; it was simply an empirical fact, when Locke was writing the *Essay*, that no corpuscles or corpuscle-sized objects could be observed by any available means.

Locke may very well have believed, further, that no corpuscles will in fact ever be observed, that our faculties are too weak, corpuscles too small, that our technology will never be adequate. This view, however, is merely practical pessimism, not a belief in in-principle unobservability, for there is no suggestion of the existence of any appropriate reason why observation is impossible. (I argue in section 2 that rather than attributing to Locke the belief that corpuscles are in principle unobservable, it is more plausible merely to characterize him as a practical pessimist.) For a claim about unobservability to count as a claim of unobservability in principle, it must be supported by a reason of the right kind. The reason must dictate categorically that corpuscles can never be observed and the reason must be theoretical, grounded in some relevant theory, be it physics, metaphysics, or psychology.

Now, it is conceivable that it might turn out to be a consequence of a well-developed corpuscularianism that single corpuscles (or single corpuscles of a certain kind) are unobservable. Here is a crude example of the sort of case I have in mind: Corpuscular theory might tell us that all visual perception (with or without the aid of a microscope) takes place by means of particles bouncing off of the bodies perceived (and then hitting the retina). Suppose further that the theory tells us that, when the particles in question are sufficiently small, only smaller particles will bounce off of a given particle (if they are of the same size or larger, the particle just sticks to them). It would follow that the smallest corpuscles would be unobservable (at least by sight). While this clearly meets my requirements, outlined in the preceding paragraph, for being an "in-principle unobservability," it is not the kind that I will be concerned with in

this paper. Whether any such unobservability holds would be a complex empirical question; the question's resolution would await refinement of the theory. Certainly Locke never committed himself to any speculations along these lines (nor have any of his interpreters thought otherwise).

An appropriately principled unobservability, for the purpose of this paper, will be based on more general theorizing. To be more specific, it will be grounded upon the *nature* of corpuscles, as defined by the basic structure of the corpuscular theory, or as constrained by the place of corpuscularism in Locke's philosophy. These grounds must dictate that corpuscles can never be observed. This is the sort of unobservability which Mandelbaum, Brook, and Alexander argue for, and which I argue against in section 3.

2.

Next, however, I examine the claim that Locke (whether he had an appropriate reason in mind or not) *believed* that corpuscles are in principle unobservable. The claim, then, is that Locke believed that for some reason it is impossible that corpuscles can be observed. First I undermine the textual evidence for the claim; afterwards I present evidence (some of it of the familiar "microscopical eyes" variety) directly against it.

The best argument that I can see for this claim rests on the following premises:¹³ (1) Locke identified the "real essences" of bodies with their corpuscular "inner constitutions." (2) If corpuscles were in principle observable, then it would be theoretically possible to have ideas of the inner constitutions of bodies. (3) Such ideas (ideas of sensation) give us knowledge, according to Locke. (4) But Locke was highly sceptical of the possibility of our gaining knowledge of real essences; in fact he sometimes seems to think that such knowledge is in principle beyond our capacities. The conclusion that seems to follow is that Locke must have thought corpuscles in principle unobservable. Now the truth of (1) and (3)¹⁴ seems indisputable, and (2) follows directly from Locke's conception of what observation is and how bodies are constituted. (4), however, is misleading. In the sorts of passages which give one the impression that (4) is generally true, Locke is in fact addressing many different issues concerning our knowledge of the natural world. I argue in what follows that in many cases where Locke might be taken, at first glance, to be impugning the possibility of knowledge of inner constitutions, he is not doing so; in the cases where he does assert an in-principle limitation on our knowledge, the

¹³ Alexander gestures at an argument of this sort. See *Ideas, Qualities and Corpuscles*, 186–87. It is not his main argument for in-principle unobservability, which I shall address in detail in section 3.

¹⁴ For (1), for example, see 2.31.6, 2.32.5, 3.3.17. For (3), see 4.4.4.

knowledge in question is of a stronger kind than that which observing corpuscles would necessarily give us.

Laurens Laudan seems to attribute to Locke a belief that corpuscles are unobservable in principle,¹⁵ in the course of a discussion of Locke's hypotheticalism. This position is based on a certain interpretation of Locke's use of the clock metaphor—that "Locke metaphorically likened nature to a clock whose internal mechanisms could never be observed"¹⁶:

In enunciating his hypothetical account of scientific explanation, Locke likened nature to a clock whose external appearances (e.g., hands moving, wheels grinding, etc.) are visible but whose internal mechanisms are forever excluded from view. The scientist's conception of nature is even "more remote from the true internal constitution" of the physical world than a "countryman's *idea* is from the inward contrivance of that famous clock at *Strasbourg*, whereof he only sees the outward figure and motions." If we knew the "mechanical affections of the particles" of bodies, "as a watchmaker does those of a watch," then we would not need to make hypotheses, but could have infallible, first-hand knowledge of nature's mechanisms. But because we can never get inside of nature's clock, we must be content to hypothesize about the possible arrangements of its parts on the basis of its external configuration.¹⁷

This gloss on Locke's use of the clock metaphor is extremely misleading, however, for it ignores the context in which Locke uses it. Locke employs the clock metaphor in just two places in the *Essay*, 3.6.9 and 39. Although Locke certainly in these contexts emphasizes human ignorance, our limited faculties, and the subtlety of "the Workmanship of the All-wise, and Powerful God, in the great Fabrick of the Universe" (3.6.9), he does so in the service of a particular point—an attack on the falseness and vanity of claims that humans sort things in terms of their real essences, when, in our present ignorance, we have no ideas of their internal constitution at all. He makes this point in the course of arguing that we in fact sort things according to nominal essences:

Therefore we in vain pretend to range Things into sorts, and dispose them into certain Classes, under Names, by their *real Essences*, that are so far from our discovery or comprehension. A blind Man may as soon sort Things by their Colours, and he that has lost his Smell, as well distinguish a Lily and a Rose by their Odors, as by those internal Constitutions which he knows not. He that thinks he can distinguish Sheep and Goats

¹⁵ "The Nature and Sources of Locke's Views on Hypotheses," in *Locke on Human Understanding*, ed. I. C. Tipton (Oxford University Press, 1977), 149–62. As Laudan does not make any explicit distinction between principled and practical pessimism, it is difficult to be certain which view he attributes to Locke, but the strength of his wording makes me think that it is the former. Also, in his paper "The Clock Metaphor and Probabilism," *Annals of Science* 22 (1966): 96, Laudan gestures at a principle requiring the unobservability of Boylean corpuscles. However, I will address this point in another context; here I simply want to examine the relevance of such a claim to the textual evidence used to illustrate and support it.

¹⁶ Laudan, "The Nature and Sources of Locke's Views on Hypotheses," 158.

¹⁷ *Ibid.*, 155.

by their real Essences, that are unknown to him, may be pleased to try his Skill in those *Species*, called *Cassowary*, and *Querechinchio*; and by their internal real Essences, determine the boundaries of those *Species*, without knowing the complex *Idea* of sensible Qualities, that each of those Names stands for, in the Countries where those Animals are to be found. (3.6.9)

In order to make this point, Locke does not need to claim that inner mechanisms are “forever excluded from view,” and I don’t believe that he does make the claim. Nor would he need to assume that we can in principle “never get inside of nature’s clock” in order to put forward a hypothetical account of scientific explanation. A practical pessimism about the nearness of inner constitutions “to our discovery or comprehension” would suffice to justify hypotheticalism.

I neither need nor want to deny that Locke was highly sceptical of the likelihood of our ever actually coming near to perceiving bodies at the corpuscular level. He thought our faculties quite limited in practice:

I deny not, but a Man accustomed to rational and regular Experiments shall be able to see farther into the Nature of Bodies, and guess righter at their yet unknown Properties, than one, that is a Stranger to them: But yet, as I have said, this is but Judgment and Opinion, not Knowledge and Certainty. This way of getting, and *improving our Knowledge in Substances only by Experience* and History, which is all that the weakness of our Faculties in this State of *Mediocrity*, which we are in in this World, can attain to, makes me suspect, that natural Philosophy is not capable of being made a Science. We are able, I imagine, to reach very little general Knowledge concerning the Species of Bodies, and their several Properties. Experiments and Historical Observations we may have, from which we may draw Advantages of Ease and Health, and thereby increase our stock of Conveniences for this Life: but beyond this, I fear our Talents reach not, nor are our Faculties, as I guess, able to advance. (4.12.10)

Here it is evident that Locke is merely expressing practical pessimism, and not any principled claim. Other passages of this kind can easily be taken to express a similar pessimism, or simply to note what was in fact the case, that the “Texture and Motion of Parts” were not, in Locke’s time, discoverable by any available means.¹⁸

Locke stressed the implications of our practical disabilities—the limitations that our (current and for the foreseeable future) inability to perceive corpuscular constitutions places upon our knowledge of bodies. In doing so, he was drawing his favorite moral, so it would not be surprising if he occasionally overstated his limitative conclusions. Nevertheless, one finds that Locke almost always expresses these limitations quite precisely, in a *conditional* form:

¹⁸ E.g. 4.3.16 can be interpreted in this way.

But, what difference in the internal real Constitution makes a specifick difference, it is in vain to enquire; whilst *our measures of Species be*, as they are, *only our abstract Ideas*, which we know; and not that internal Constitution, which makes no part of them. (3.6.22)

But though we are not without *Ideas* of these primary qualities of Bodies in general, yet not knowing what is the particular *Bulk, Figure, and Motion*, of the greatest part of the Bodies of the Universe, we are ignorant of the several Powers, Efficacies, and Ways of Operation, whereby the Effects, which we daily see, are produced. (4.3.24)

In these passages, and many others like them,¹⁹ Locke argues that, lacking the ideas (and, thus, the knowledge) of inner constitutions which corpuscular observation could give us, we lack the foundations for a strict science of body. His negative pronouncements, however, are conditioned on the simple *fact* that we do not have perceptual access to corpuscles (e.g., “whilst we are destitute of Senses acute enough, to discover the minute Particles of Bodies, and to give us *Ideas* of their mechanical Affections, we must be content to be ignorant of their properties and ways of Operation” [4.3.25]); they do not presuppose that corpuscles are in principle unobservable.

Locke clearly held that perceptual access to corpuscular constitutions is a missing necessary condition for scientific knowledge of bodies. It is a mistake, however, to think that he supposed it to be sufficient.²⁰ If we could see the corpuscular constitutions of things, we would gain a *certain sort* of knowledge. We would have ideas of the textures of the parts of bodies, view particles of a certain size and figure and the intricate arrangements of those particles.²¹ Since we would have ideas of the mechanical affections of bodies, we could watch and even understand the mechanical interactions between bodies: “The dissolving of Silver in *aqua fortis*, and Gold in *aqua Regia*, and not *vice versa*, would be then, perhaps, no more difficult to know, than it is to a Smith to understand, why the turning of one Key will open a Lock, and not the turning of another” (4.3.25).²² The knowledge with which corpuscular observation could supply us is, however, limited. Locke raises separate considerations which he believes put a complete understanding of bodies, sufficient for scientific knowledge, beyond our reach.²³ These considerations, having to do with

¹⁹ See also 2.31.6, 4.3.11, 4.3.14, 4.3.26, 4.6.5, 4.6.14.

²⁰ On this see Woolhouse, *Locke's Philosophy of Science and Knowledge*, 136–37.

²¹ 2.23.11.

²² This passage is followed immediately by the passage quoted at the end of my preceding paragraph.

²³ The considerations which I shall briefly note below are treated in some detail by Margaret Wilson in her paper “Superadded Properties: The Limits of Mechanism in Locke,” *American Philosophical Quarterly* 16 (1979): 143–50. I agree with the position she takes on p. 144: “At the minimum, Locke’s claims that some presumed properties of matter cannot be conceived as ‘natural’ consequences of Boylean primary qualities imply that human ignorance about bodies is not entirely a question of our lacking access to the details of any particular body’s ‘insensible corpuscles.’”

conceivability, account for a strain of principled pessimism in Locke's discussions of the possibility of human knowledge of the physical world. Locke has philosophical reasons for holding that a complete understanding of bodies is in principle beyond our reach, reasons which neither arise from nor require the in-principle unobservability of corpuscles.

In 2.23.22–29, Locke argues that the cohesion of the minute parts of body and the communication of motion by impulse are both unintelligible to us. Since Locke did not doubt that the minute parts of body do somehow cohere nor that motion is communicated by impulse,²⁴ this obviously places grave limitations on our understanding of the natural world. As Yolton notes,²⁵ the unintelligibility of cohesion also rules out knowledge, or, at least, any full understanding, of the real essences of bodies, since we then cannot understand how bodies are extended: “For since Body is no farther, nor otherwise extended, than by the union and cohesion of its solid parts, we shall very ill comprehend the *extension* of Body, without understanding wherein consists the union and cohesion of its parts” (2.23.24). It is clearly *these* considerations, which he has just raised, and not any presumed in-principle unobservability, that lead Locke in 2.23.28 to question our ability to penetrate into the “Causes, and manner of production” of our ideas.

Locke also argues at some length that the connection between physical particles in motion and the ideas produced in us by them in perception is inconceivable by us: “But our Minds not being able to discover any *connexion* betwixt these primary qualities of Bodies, and the sensations that are produced in us by them, we can never be able to establish certain and undoubted Rules, of the Consequence or *Coexistence* of any secondary Qualities, though we could discover the size, figure, or motion of those invisible Parts, which immediately produce them. We are so far from knowing what figure, size, or motion of parts produce a yellow Colour, a sweet Taste, or a sharp Sound, that we can by no means conceive how any *size, figure, or motion* of any Particles, can possibly produce in us the *Idea* of any *Colour, Taste, or Sound* whatsoever; there is no conceivable *connexion* betwixt the one and the other” (4.3.13).²⁶ This is an extremely serious principled limitation on our knowledge of bodies, from Locke's point of view, for, as Woolhouse argues,²⁷ it prevents us from ever fully understanding how a body's sensible qualities “flow” from its “real essence.” This consideration is the true source of much of Locke's pessimism about our potential knowledge of nature:

²⁴ “Constant Experience makes us sensible of both of these, though our narrow Understandings can comprehend neither” (2.23.28).

²⁵ *Locke and the Compass of Human Understanding*, 79–80.

²⁶ See also 4.3.28.

²⁷ *Locke's Philosophy of Science and Knowledge*, 137.

Had we such *Ideas* of Substances, as to know what real Constitutions produce those sensible Qualities we find in them, and how those Qualities flowed from thence, we could, by the specifick *Ideas* of their real Essences in our own Minds, more certainly find out their Properties, and discover what Qualities they had, or had not, than we can now by our Senses: and to know the Properties of *Gold*, it would be no more necessary, that *Gold* should exist, and that we should make Experiments upon it, than it is necessary for the knowing the Properties of a Triangle, that a Triangle should exist in any Matter, the *Idea* in our Minds would serve for the one, as well as the other. But we are so far from being admitted into the Secrets of Nature, that we scarce so much as ever approach the first entrance towards them. (4.6.11)

The ideas that Locke is here bemoaning our lack of are ideas that no observation of corpuscles would give us, and ideas that are beyond our ken, by Locke's own arguments.

Because "we can discover no natural connexion" of "the coherence and continuity of the parts of Matter; the production of Sensation in us of Colours and Sounds, etc. by impulse and motion; nay, the original Rules and Communication of Motion" with our ideas (4.3.29), Locke holds that the "discovery of the necessary Connexion, and *Co-existence*, of the Powers, which are to be observed united in several sorts of [bodies]" (4.3.16) is beyond our reach, so that "we are not capable of a philosophical *Knowledge* of the Bodies that are about us, and make a part of us" (4.3.29). These considerations, which impose strict limitations upon our knowledge of nature, are quite distinct from considerations having to do with the observability of corpuscles. In fact, Locke explicitly distinguishes the two sorts of considerations, as I shall show²⁸ in making a positive case for the position that Locke believed corpuscles to be observable in principle.

I have been arguing that it is unnecessary to attribute the belief that corpuscles are in principle unobservable to Locke. I want now, briefly, to argue that it is also quite uncharitable for four reasons, which I will put forward in roughly the order of increasing gravity:

(1) As I have previously detailed, a large number of Locke's negative pronouncements about our potential knowledge of body are explicitly conditioned on the fact that our senses are not acute enough to perceive the minute particles of bodies. It is unclear why Locke would use this formulation so frequently if he thought that the possibility of our observing such particles could be ruled out in principle.²⁹

(2) Several passages in the *Essay* suggest that the only thing which prevents

²⁸ In reason (4) below.

²⁹ Buchdahl argues (plausibly, I believe) from such passages that our ignorance of primary qualities of the parts of body must be of an empirical kind, due mainly to the minuteness of corpuscles. See *Metaphysics and the Philosophy of Science*, 210.

us from seeing corpuscles is their not being “big enough singly to be discerned” (2.8.22).³⁰ Most notably, Locke develops a direct analogy, at some length, between bodies too remote for us to perceive, and bodies too minute for us to perceive, amongst which he includes “insensible corpuscles”: “If a great, nay far the greatest part of the several ranks of *Bodies* in the Universe, scape our notice by their remoteness, there are others that are no less concealed from us by their *Minuteness*. These insensible Corpuscles, being the active parts of Matter, and the great Instruments of Nature, on which depend not only all their secondary Qualities, but also most of their natural Operations, our want of precise distinct *Ideas* of their primary Qualities, keeps us in an incurable Ignorance of what we desire to know about them” (4.3.25).³¹ Moreover, Locke believes that the great chain of being is continuous, “without any great or discernable gaps” (4.16.12). To suppose that corpuscles are unobservable in principle is, in effect, to posit a sort of gap. These passages, then, support the thesis that Locke thought of corpuscles as observable in principle.

(3) Locke explicitly raises the possibility of our perceiving the inner (corpuscular) constitutions of things in several places,³² and he describes the possibility in some detail in the well-known microscopical eyes passages:

Had we Senses acute enough to discern the minute particles of Bodies, and the real Constitution on which their sensible Qualities depend, I doubt not but they would produce quite different *Ideas* in us; and that which is now the yellow Colour of Gold, would then disappear, and instead of it we should see an admirable Texture of parts of a certain Size and Figure. (2.23.11)

Nay, if that most instructive of our Senses, Seeing, were in any Man 1000, or 100000 times more acute than it is now by the best Microscope, things several millions of times less than the smallest Object of his sight now, would then be visible to his naked Eyes, and so he would come nearer the Discovery of the Texture and Motion of the minute Parts of corporeal things; and in many of them, probably get *Ideas* of their internal Constitutions. . . . And if by the help of such Microscopical Eyes (if I may so call them,) a Man could penetrate farther than ordinary into the secret Composition, and radical Texture of Bodies, he would not make any great advantage by the change, if such an acute Sight would not serve to conduct him to the Market and Exchange. (2.23.12)

Locke goes on to warn us that such microscopical vision would be of little use to us, since things would appear very differently to us and our ordinary purposes are optimally served by ordinary appearances. The important point, however, is that he does not in the least appear to think that there is anything nonsensical about the possibility of microscopical vision, nor does he suggest that there is any principled limitation upon how closely we could examine the

³⁰ See also 2.8.23.

³¹ See also 4.3.25.

³² See 2.21.73 and 4.3.25.

radical textures of bodies. How odd it would be if Locke had *refrained* from mentioning a principled limitation upon viewing corpuscles at each of the places where he raises the possibility of our perceiving the corpuscular constitution of bodies.

(4) I have already noted Locke's argument that there is no conceivable connection between any secondary quality and the primary qualities it depends on. In the course of this argument, Locke distinguishes a less incurable and a more incurable ignorance:

Besides this Ignorance of the primary Qualities of the insensible Parts of Bodies, on which depend all their secondary Qualities, there is yet another and more incurable part of Ignorance, which sets us more remote from a certain Knowledge of the *Co-existence*, or *Inco-existence* (if I may so say) of different *Ideas* in the same Subject; and that is, that there is no discoverable connection between any *secondary Quality*, and those *primary Qualities* that it depends on. (4.3.12)

. . . we neither know the real Constitution of the minute Parts, on which their Qualities do depend; nor, did we know them, could we discover any necessary *connexion* between them, and any of the *secondary Qualities*: which is necessary to be done, before we can certainly know their *necessary co-existence*. (4.3.14)

Locke seems to be directly acknowledging that, while it is simply a fact that we do not have ideas of the primary qualities of the minute parts of bodies, it is *impossible* for us to fully understand the connection between primary qualities and secondary qualities. Locke regards the sort of ignorance that observing corpuscles could remedy as less incurable, and, *a fortiori*, not in principle incurable.

3.

The extant arguments which attempt to supply Lockean *reasons* for holding that corpuscles are unobservable in principle seem to be of two kinds. Brook and Mandelbaum illustrate the first kind, which I shall label the unperceivable causes argument. Alexander's argument is an instance of the second kind, the uncolored corpuscles argument. I turn now to the unperceivable causes argument.

Brook provides the clearest formulation of this argument for in-principle unobservability:

That the alleged "particles" of atomic or corpuscularian theories are "insensible," is entailed by a certain version of what can be called the "causal theory of perception." This version runs essentially as follows: there exist real (material) objects independent of minds. The nature ("real essence" in Locke's terminology) of such objects is construed as a certain "atomic" structure, by which is meant a certain combination of "particles" whose nature is exhaustively described in terms of qualities like shape, motion, mass (or the less precise term "solidity"). . . . [T]hese alleged particles are said

to interact by certain modes of transmission with the nervous and sensory systems of sentient beings (these latter construed also as certain groupings of these particles). The modes of interaction between the “object” and the physiological systems would ideally be described in terms of mechanical laws. . . . The end result of such interaction is sensation, or the having of “ideas.” Although the spatial terminology is somewhat ambiguous and metaphorical, we are to understand that the *locus* of the sensation is “in” the sentient being. Expressed otherwise, we are immediately acquainted not with the external objects which are causally related to the occurrence of our “ideas” but only with the “ideas” caused.

It is a consequence of the above theory that the ultimate “particles” which constitute the atomic structure of a physical object, are in principle unobservable; an unobservability certainly not rooted in some empirical limitation of our powers of perceptual discrimination, but rooted in the claim that the content of a perceptual consciousness (in terms of the colors, sounds, tastes, feels, smells) is an effect of the interaction of the particles of “objects” with the particles of our sensory and nervous systems.³³

Brook holds that Lockean corpuscles are unobservable in principle in virtue of their status as causes of our ideas. Locke’s causal theory of perception, Brook thinks, entails that we perceive only the ideal effects of corpuscles, not their corpuscular causes.³⁴ This is the Lockean principle, then, on which in-principle unobservability rests.

I interpret Mandelbaum as holding roughly the same view as Brook,³⁵ although he states it less perspicuously. As far as I can tell, the following passage provides Mandelbaum’s only justification for his claim that “the ‘insensible’ (i.e., imperceptible) parts of matter *cannot*, by definition, be presented to us in sensory experience”³⁶: “Finally, we may note that Locke is willing to suggest an account of our visual perception of ‘the extension, figure, number, and motion of bodies of an observable bigness’, and this account invokes the action of ‘singly imperceptible bodies’ (i.e., particles) which come from the objects to our eyes and convey a motion to our brains. Such an account of the origins of our ideas of the so-called primary qualities of macroscopic objects surely demands that we relinquish the view that our ideas of the qualities of these objects are replicas of the qualities as they exist in the bodies themselves: *that which exists independently of us, and causes our ideas of the primary qualities of an*

³³ Brook, *Berkeley’s Philosophy of Science*, 94.

³⁴ Brook acknowledges in a footnote that not every causal theory of perception need have this consequence, but he supposes that the Lockean theory which Berkeley addresses *does* have this consequence. *Ibid.*, n. 28.

³⁵ Laudan might be put into the unperceivable causes camp as well. In “The Clock Metaphor and Probabilism,” 96, he indicates that Boyle “accepts the corpuscularian theory of matter, and with it the theory of knowledge which makes corpuscles unobservable in principle.” Although he does not say so explicitly, it seems from “Locke’s Views on Hypotheses” that he attributes the same position to Locke.

³⁶ Mandelbaum, *Philosophy, Science and Sense Perception*, 15 (my emphasis).

object, is not itself capable of being perceived."³⁷ Mandelbaum, too, holds that Locke's account of perception entails that the physical causes of our ideas cannot themselves be perceived.³⁸

The difficulty with the unperceivable causes view is revealed by examining the status of macroscopic objects. If ordinary, macroscopic objects are physical objects, i.e., causally efficacious collections of corpuscles, then ordinary, macroscopic objects must (like individual corpuscles) be in principle unobservable. I take this to be a *reductio*. That is, if Brook and Mandelbaum affirm the "unperceivable causes" principle, they must deny that ordinary, macroscopic objects are physical objects in order to avoid the absurd conclusion that we never perceive ordinary objects at all. I take it that the absurdity of the conclusion is manifest; after all, the aim of the causal theory of perception is, as Mandelbaum notes, to explain how we perceive "bodies of an observable bigness." It must be, then, according to the unperceivable causes view, that the ordinary, macroscopic objects which we perceive are *not* collections of corpuscles, but some other kind of thing. This, I take it, accounts for Brook's use of scare quotes around the word 'object'; the physical objects in question *are not* the ordinary objects we encounter in experience.

If the unperceivable causes view is to have even *prima facie* plausibility, then, ordinary macroscopic objects (which we do perceive) must be something distinct from physical objects (which we allegedly cannot perceive because, according to the corpuscular hypothesis, they are causally efficacious collections of corpuscles). There are two major problems with this view: (1) It saddles Locke with a problematic and, it seems, un-Lockean philosophy of perception. (2) It undercuts the explanatory value of the corpuscular theory, from a Lockean perspective.

If the macroscopic objects we perceive are not physical objects, what else can they be? They must be either collections of ideas, or some third kind of thing, "perceptual objects." The first option seems much more Berkeleian than Lockean. The second is rather elusive. Although Locke's views on this issue are not easy to pin down completely, it does seem clear from the *Essay* that Locke holds that we perceive physical objects. Locke tells us that our observation is employed about *external* sensible objects (2.1.2), that *external, material* things are the objects of sensation (2.1.4), that the object of a sensation is a *corporeal* being (2.23.15), that the things we see and feel exist "without us"

³⁷ Ibid., 18 (my emphasis).

³⁸ It may be that Mandelbaum doesn't really mean to claim that, according to Locke, we don't perceive physical things at all, but rather that we don't perceive them as they are in themselves. (This way of interpreting Mandelbaum was suggested to me in conversation by Stephen Menn.) If that were his claim, I would find it unobjectionable. However, I would then see no reason at all for his holding that corpuscles are unperceivable in principle for Locke.

(4.11.3). It is true that, according to Locke, we perceive physical objects mediately, by having ideas of them, and the relations between the objects and the ideas and us are not philosophically unproblematic.³⁹ But the two alternative accounts of Locke's philosophy of perception, one of which would have to be given by any advocate of the unperceivable causes argument for in-principle unobservability, turn all the things we see and feel into nonphysical, noncorporeal objects, and are therefore suspect as Locke-interpretation. The vague sketch I have given of Locke's account of perception, however it is to be filled out, does *not* force any in-principle wedge between perceiving ordinary macroscopic objects and perceiving corpuscles, since both are physical objects and would be perceived (if corpuscles could be perceived) in the same way.

The other problematic consequence of the unperceivable causes view, because it must make corpuscles and ordinary perceived objects metaphysically different kinds of things, is that it destroys, from Locke's point of view, the motivation for corpuscularian scientific theory. If corpuscles aren't bodies of the same kind as the macroscopic bodies whose qualities we are familiar with from perceptual experience, then corpuscles must be rather mysterious. The great virtue of corpuscularianism, which was thought to render it uniquely intelligible and explanatory, was that the theoretical entities of its explanations are tiny *bodies*. Despite the minuteness of corpuscles, their interactions can be understood, the corpuscularians held, because they exhibit the same behavior and obey the same mechanical laws as perceived macroscopic bodies.⁴⁰ The properties of a macroscopic body are supposed to be explained in terms of the primary qualities (and arrangements and motions) of its material parts. The corpuscular parts have the *same* types of primary qualities as perceivable macroscopic objects (from which we derive our ideas of the primary qualities), according to Locke (2.31.6). This is part of what makes corpuscular explanations more intelligible than explanations in terms of substantial forms, of which we have no ideas (2.31.6). Locke stresses the importance of analogy in scientific explanation; he thinks it is our only guide in formulating probable hypotheses about what we do not perceive. He thinks it is a reliable guide because he has a firm belief in the continuity of all the parts of creation.⁴¹ The unperceivable causes argument destroys the analogy, and with it the corpuscular theory's claim to intelligibility.

³⁹ It is important to Locke's account that physical objects *cause* our ideas. By immediately perceiving ideas (some of which resemble their causes) we mediately perceive their causes.

⁴⁰ Here I echo Laudan, "Locke's Views on Hypotheses," 160. I am also in agreement with Yolton, *Locke and the Compass of Human Understanding*, 51.

⁴¹ 4.16.12. Laudan notes that Descartes, Boyle, and Hooke had similar views about the continuity of nature, which led them, like Locke, to "construe atoms and their properties as natural extensions of the properties of macroscopic bodies." See "Locke's Views on Hypotheses," 159.

I have argued, then, that it makes for very bad Locke-interpretation to hold that corpuscles must be unperceivable in virtue of their status as causes of ideas. The unperceivable causes principle should therefore be rejected. It should be allowed, rather, that (for all we know from Locke's philosophy of perception) we might perceive corpuscles just as we perceive macroscopic physical objects, by having ideas of them.

I now turn to Peter Alexander's argument for the in-principle unobservability of corpuscles. After I have examined and responded to his argument, it will be an easy step to formulate and address a closely related "uncolored corpuscles" argument based on less controversial premises.

From Alexander's discussion on p.184, I extract the following argument⁴²: (1) Secondary qualities are powers to produce ideas (of color, hardness, taste, sound, odor, etc.) in us. (2) If a body does not have these powers, we cannot distinguish it from its surroundings, so we cannot (in principle) perceive it. (3) But the powers that are secondary qualities are textures (patterns or arrangements) of corpuscles. (4) Single corpuscles have no textures. It follows from these four premises that single corpuscles are in principle unobservable. Now, it seems indisputable that Locke was committed to (1); (2) seems straightforwardly true, in the context of a Lockean idea theory; and (4) is analytic.⁴³ I shall argue that (3) must be abandoned for two sorts of reasons. There are straightforward, serious exegetical problems with (3); moreover, I will show that, viewed properly, Alexander's argument is itself a better *reductio* of (3) than it is an argument for in-principle unobservability.⁴⁴

⁴² I take this to be Alexander's main argument for unobservability in principle. The only other considerations he raises in favor of his view are (1) that "a single corpuscle is just too small and too simple for its solidity to have a detectable effect on our sense organs" (*Ideas, Qualities, and Corpuscles*, 184), which is no argument for *in-principle* unobservability. (2) that Locke's pessimism about knowledge of real essences may be explained by his belief in in-principle unobservability (*ibid.*, 186–87), a point which I have already addressed, and (3) a suggestion of a related uncolored corpuscles argument based on less controversial premises, which I address shortly.

⁴³ Obviously an undivided particle cannot have a texture. Alexander also holds that the smallest stable aggregates of undivided particles are not sufficiently complex to have textures, in his sense.

⁴⁴ The most direct argument that I can find in Alexander for (3) is the following: "It is of great importance to bear in mind what I have said about Boyle's and Locke's use of 'texture' as a technical term [meaning 'arrangement of corpuscles']. A consequence of this is that secondary qualities are those textures of bodies that produce sensations of colours, etc. in us. This is part of the attempt of both Boyle and Locke to avoid explanations that rely on occult qualities; if causes of sensations were something over and above these textures they would be occult" (*ibid.*, 169; see also 151). I do not think, however, that this consideration motivates the identification of secondary quality powers with textures. A "bare power," from Locke's and Boyle's perspective, need not be regarded as occult unless it is either postulated *ad hoc*, with no explanatory basis, or it is regarded as substantial. The powers that are secondary qualities causally result from primary qualities of corpuscles, and they are *mere* powers, or abilities, not substantial forms.

Alexander does provide other considerations in support of (3) (e.g., he devotes Chapter 7 to

The most obvious problem with identifying secondary (and tertiary) qualities with textures is that Locke relentlessly repeats his claim that they are *mere* powers, *barè* powers, *nothing* in the objects *but* powers⁴⁵: “But though *these two later sorts of Qualities are Powers barely*, and nothing but Powers, relating to several other Bodies, and resulting from the different Modifications of the Original Qualities; yet they are generally otherwise thought of” (2.8.24). Although Locke admittedly often employs these formulations in the course of making the point that our ideas of secondary qualities do not resemble anything in the objects, it nevertheless seems incredible, if he had identified secondary qualities with textures, that he would have made such obviously misleading statements so frequently and emphatically. It is also noteworthy that Locke, in his chapter on power, emphasizes that “*Powers are Relations, not Agents*” (2.21.19). It seems, however, that Alexander, by identifying secondary qualities with textures, turns powers into agents of a sort, for textures are causally active and therefore ought to be regarded as exerting or having powers, rather than being them. Most seriously, however, Alexander’s thesis renders one of Locke’s explicit doctrines completely mysterious and unjustifiable. If Locke identified secondary qualities with textures, how could he have thought that “there is no discoverable connection between *any secondary quality and those primary qualities* that it depends on” (4.3.12) and that our ignorance of this connection is more incurable than our ignorance of the primary qualities of the insensible parts of bodies (4.3.14)? If secondary qualities are textures, then they just are a certain arrangement of primary qualities (or of corpuscles so qualified), and if we knew the primary qualities of the insensible parts of bodies, we would certainly know the textures. We would not thereby understand how a certain texture gives rise to a certain sensation, but on Alexander’s view that would not be required in order to understand how a secondary quality (a texture) depends upon primary ones. We would thus have a perfectly clear picture of a connection that Locke tells us is perfectly opaque.

Having finished my exegetical arguments directed specifically against premise (3), I want to return for a closer look at Alexander’s argument as a whole. The problem with accepting the identification made in premise (3) is that, in conjunction with (1), (2), and (4) (which are uncontroversial), it arbitrarily restricts to textured bodies the powers to produce certain kinds of ideas. How can one rule out a priori the possibility of a corpuscle (or small clump of corpuscles, not sufficiently complex to constitute a texture, or pat-

making plausible the claim that powers can be intrinsic properties, so that the identification is not, he argues, simply a category mistake), but his argument is roundabout and there are no texts which force the identification.

⁴⁵ See also 2.8.10, 14, 15, 22, 23, 2.23.8, 2.31.2.

tern) having a power (in virtue of its size, shape, hardness, and motion), *under certain circumstances*, to give rise to an idea of color, for example? (One might make such a claim, a posteriori, on scientific grounds, given a well-developed corpuscularianism, but neither Boyle nor Locke makes any such empirical claim.)

In fact, this sort of a priori legislation is completely antithetical to the corpuscularianism of Boyle and Locke. Both Boyle and Locke emphasize the fact that most of the qualities we attribute to a body depend heavily on the body's relations to many other bodies extrinsic to it. Boyle is particularly explicit on this point. He frequently warns us that "in reference to the production of qualities, a body is not to be considered barely in itself, but as it is placed in and is a portion of the universe."⁴⁶ Soon after arguing that "we explicate colours, odours, and the like sensible qualities, by a relation to our senses,"⁴⁷ he issues a similar relevant caution: "the actions of particular bodies upon one another must not be barely estimated as if two portions of matter of their bulk and figure were placed in some imaginary space beyond the world, but as being situated in the world constituted as it now is, and consequently as having their action upon each other liable to be promoted or hindered or modified by the actions of other bodies besides them."⁴⁸ Most damagingly for Alexander's position, Boyle explicitly advances considerations in support of the possibility of a single corpuscle being endowed, in virtue of relations with other bodies, with sensible qualities:

For if corpuscles, without losing that texture which is essential to them, may (as we have showed they may) have their shape or their surfaces or their situation changed, and may also admit of alteration (especially as these corpuscles make up an aggregate or congeries) as to motion or rest, as to these or those degrees or other circumstances of motion, as to laxity or density of parts, and divers other affections, why should we not think it possible that a single (though not indivisible) corpuscle, and much more an aggregate of corpuscles, may by some of these or the like changes—which, as I was saying, destroy not the essential texture—be fitted to produce divers other qualities, besides these that necessarily flow from it? Especially considering (which is that I have now to add) that, the qualities commonly called sensible and many others too being according to our opinion but relative attributes, one of these now-mentioned alterations, though but mechanical, may endow the body it happens to with new relations both to the organs of sense and also to some other bodies. and consequently may endow it with additional qualities.⁴⁹

⁴⁶ Robert Boyle, "An Introduction to the History of Particular Qualities," in *Selected Philosophical Papers of Robert Boyle*, ed. M. A. Stewart (Manchester University Press, 1979), 114. All citations of Boyle will be from this volume. See also, "The Origin of Forms and Qualities," 26–27.

⁴⁷ "The Origin of Forms and Qualities," 32. See also the passages immediately preceding.

⁴⁸ *Ibid.*, 32–33.

⁴⁹ "Introduction to Particular Qualities," 114–15. It seems from Boyle's use of the term 'texture' here that he is using 'corpuscle' to mean 'small, stable clump of undivided particles', so

It is evident from this passage that Boyle would see no reason to rule out the possibility of a single corpuscle or a tiny clump of corpuscles gaining a power to give rise to a color experience under certain peculiar, microscopical conditions, for the corpuscle's new relations to other bodies (the microscope, particles of light) might endow it with additional sensible qualities (by changing its relations to our sense organs).

Locke is less articulate on this issue, but it seems clear that he follows Boyle's line. He too highlights the extrinsic factors which give rise to the qualities of a body, "the different Motions and Impulses made in and upon them [individual substances] by Bodies from without, upon which depends, and by which is formed the greatest and most remarkable part of those Qualities we observe in them, and of which our complex *Ideas* of them are made up."⁵⁰ In typical Lockean fashion, he emphasizes our inability ever to know all the powers of any body, for its powers, being heavily dependent on its external relations, are virtually infinite⁵¹: "The simple *Ideas* whereof we make our complex ones of Substances, are all of them (bating only the Figure and Bulk of some sorts) Powers; which being Relations to other Substances, we can never be sure that we know all the Powers, that are in any one Body, till we have tried what Changes it is fitted to give to, or receive from other Substances, in their several ways of application: which being impossible to be tried upon any one Body, much less upon all, it is impossible we should have adequate Ideas of any Substance, made up of a Collection of all its Properties" (2.31.8). Locke, too, would be suspicious of Alexander's arbitrary limitations on the powers of corpuscles and would reject, for this reason alone, the identification of secondary qualities with textures.

It is now obvious how to address a closely related worry about the possibility of observing corpuscles which does not presuppose Alexander's controversial identification. The worry is this: Corpuscular theory tells us that corpuscles are uncolored; they possess only primary qualities—size, shape, hardness or impenetrability, mobility. But isn't it impossible for us to see uncolored corpuscles? This objection can be met as follows: It is certainly true that corpuscular theory explains our ordinary color experience in terms of certain corpuscular textures, the arrangements of corpuscles on a body's surface. It may be right to say that, according to a Lockean corpuscular theory, individual corpuscles are not, properly speaking, colored. For that matter, it may also be right to say that

that a corpuscle may itself have a sort of texture. However, his argument does not depend crucially on a corpuscle's having internal complexity, since even an undivided corpuscle may have its situation or its motion altered, and may thereby enter into new relations with other bodies and the organs of sense.

⁵⁰ 4.6.12. See also 11.

⁵¹ See also 3.9.13.

physical objects are not, properly speaking, colored, that only our ideas are colored, in a strict sense. The observability of corpuscles, however, does not depend on how either of these questions of Locke-interpretation are answered. In order to see a corpuscle, we do have to see it as colored (as well as as extended and shaped). All that this requires, however, is that a corpuscle be able to give rise to a certain sort of perceptual experience of color, under the appropriate microscopical circumstances.⁵² Corpuscular theory gives us no reason to deny this kind of power, in principle, to corpuscles.⁵³ I have argued that Boyle and Locke would be hostile to such an arbitrary denial, which would amount to a priori legislation on an empirical question.

I have shown, then, that the principles upon which the “unperceivable causes” and “uncolored corpuscles” arguments for in-principle unobservability are based are not Lockean principles and lead to highly un-Lockean conclusions. They should therefore be rejected.

The arguments of sections 2 and 3 are mutually supporting. Since, as I argue in section 2, Locke believed that corpuscles were *observable* in principle, it is not surprising that in section 3 I find no genuinely Lockean principles which dictate unobservability. Section 3, by demonstrating that no principled *Lockean* arguments for unobservability have been outlined by Locke’s commentators, supplies a strong additional reason against the claim that Locke *believed* that corpuscles were unobservable in principle: such a belief, it seems, would have been philosophically and scientifically unmotivated. Moreover, it would have tended to undermine Locke’s natural philosophy. The answer, then, to the title question must be a resounding “no.”⁵⁴

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⁵² In order for this to count as observing a corpuscle (rather than just being causally affected by a corpuscle) the experience must be of the right kind, caused in the right way. For my purposes here, I set aside difficult questions about what exactly the right kind and the right way are.

⁵³ Daniel Garber answers the uncolored corpuscles objection much as I do, although without the textual support I provide. He credits Phillip Cummins and Ian Tipton for bringing the problem to his attention. See “Locke, Berkeley, and Corpuscular Scepticism,” 193–94 n.17.

⁵⁴ I would like to thank Stephen Menn and two anonymous referees for helpful comments and suggestions on a previous draft of this paper. I am especially indebted to Margaret Wilson for detailed comments on several incarnations of this work.