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1. MACHINES AS MODELS OF INTELLIGIBILITY

The intelligibility of our artifacts suggests to many seventeenth century thinkers that nature works along analogous lines, that the same principles that explain the operations of artifacts explain the operations of natural bodies.¹ We may call this belief 'corpuscularianism' when conjoined with the premise that the details of the analogy depend upon the sub-microscopic textures of ordinary bodies and upon the rapidly moving, imperceptibly tiny corpuscles that surround these bodies.² Locke's sympathy for corpuscularianism comes out clearly where he describes the implications of our inability to perceive the sub-microscopic world. If we could, he conjectures, various perplexities would be unknotted. We would solve mysteries of pharmacology, since

did we know the Mechanical affections of the Particles of *Rhubarb*, *Hemlock*, *Opium*, and a *Man*, as a Watchmaker does those of a Watch, whereby it performs its Operations, and of a File which by rubbing on them will alter the Figure of any of the Wheels, we should be able to tell before Hand, that *Rhubarb* will purge, *Hemlock* kill, and *Opium* make a man sleep; as well as a Watch-maker can, that a little piece of Paper, laid on the Balance, will keep the Watch from going, till it be removed; or that some small part of it, being rubb'd by a file, the Machin would quite lose its Motion, and the Watch go no more³ (4.3.25).

Locke borrows the expression 'mechanical affections' from Robert Boyle, who uses it to denote motion, size, figure, and arrangement of parts "because to them men willingly refer the various operations of mechanical engines"⁴. According to Locke, if we could make out the minute mechanical affections of bodies, chemistry would also benefit. Two chemical phenomena,

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 (*ibid.*).

The watchmaker's inferences about her watches and the smith's understanding of his locks are treated as models of prediction and comprehension. Artisans have what natural philosophers would have if human eyesight were much better.

Locke's analogy between the artisan and the keen-eyed scientist runs deeper than the observations that they both understand the objects of their attention and that they both can make predictions about them. He matches the capacity of a piece of paper to stop a watch with the capacity of opium to stop a person, and he matches the capacity of a file to destroy a watch with the capacity of hemlock to destroy a person.⁵ He also suggests that the explanation of why keys open some locks but not others will be like the explanation of why *aqua fortis* dissolves some noble metals but not others. His use of the term 'mechanical affections' and his choice of examples show that Locke supposes that explanations used by watchmakers and locksmiths would transfer smoothly to natural philosophy, if we knew the sub-microscopic textures of bodies.

In fact, he supposes that some forms of mechanical explanation are good enough to explain other forms of mechanical explanation. For example, though watchmakers appeal to the spring of coils, Locke believes that this force would be explained if we could see the "Configuration of the minute particles of the Spring of a Clock" (2.23.12).⁶ Corpuscularianism would be a fecund theory if we had 'microscopical eyes'; some of the watchmaker's explanatory tools would suffice to explain the efficacy of others.⁷

An Essay Concerning Human Understanding is, in the first instance, a work of epistemology. Locke believes two striking epistemic theses about corpuscularianism. First, he believes that if we knew the mechanical affections of a body, we would be able to deduce its derivative properties with mathematical rigor. Second, he believes that alternatives to corpuscularianism are inconceivable. Properly understanding these theses takes some work, but after we do that work, we will have a

good picture of how Locke's epistemology justifies and limits his good opinion of corpuscularianism.

2. THE DERIVATION OF PROPERTIES FROM CORPUSCULARIAN REAL ESSENCES

2.1 Mechanical Explanation and Mathematical Inference

Locke tells us in 2.31.6 that if we had a definite idea of the real essence of a body, then the Properties we discover in that Body, would depend on that complex *Idea*, and be deducible from it, and their necessary connection with it be known; as all the Properties of a Triangle depend on, and as far as they are discoverable, are deducible from the complex *Idea* of three Lines, including a Space.

A little later in the section, he tells us that “the farthest I can go, is only to presume, that it being nothing but Body, its real Essence, or internal Constitution, on which these Qualities depend, can be nothing but the Figure, Size, and Connexion of its solid parts”. The implication is that the properties of the body can be rigorously deduced from the primary qualities of its microphysical parts.

How are these deductions supposed to run?⁸

In an important recent paper, Lisa Downing argues that Locke believes that corpuscularianism is uniquely perspicuous because it “asserts that the real essence of body corresponds to the nominal essence we assign to ‘body.’”⁹ According to her, Locke believes that the qualities that corpuscularians consider explanatory also make up the ordinary nominal essence of body, and, for that reason, he considers corpuscularianism especially intelligible.

In my opinion, this is doubly wrong. First, Locke does not believe that the ideas of all primary qualities go into the nominal essence of body. In a place where he is careful to distinguish the components of ideas from the features of the corresponding thing, he writes, “*Body* stands for a solid extended figured Substance” (3.10.15, but compare 2.13.11). Solidity, extension, and figure are all constituents of the abstract idea of body. However, texture, mobility, bulk, and number are not

constituents of that idea. Locke argues, of course, that primary qualities are inseparable from bodies (2.8.9), but that is a substantive thesis and not a trifling, analytic one.¹⁰ Second, though the ideas in the nominal essence of body are in fact explanatory, Locke does not believe that belonging to a nominal essence confers any special intelligibility to a quality. Instead, he argues that nominal essences are arbitrary to a certain extent (3.6.26) and do not reveal the “most material differences and agreements” between kinds in nature (3.6.30).

Far from thinking that primary qualities are only interesting because the corresponding ideas are included in the nominal essence of bodies, Locke believes that knowledge of them allows us to derive rigorously some of the dependent features of bodies. The derivations are hypothetical in the case of the naturalist who might discover the microphysical texture of bodies, but actual in the analogous cases of seventeenth century artisans. If we are to understand why Locke considers corpuscularianism especially intelligible, we will do well to examine the indirect comparison he draws between mechanical inferences and mathematical ones.

Right before he compares natural philosophers who know the very fine textures of bodies to artisans, he compares such philosophers to mathematicians. If we could “discover the Figure, Size, Texture, and Motion of the minute Constituent parts of any two Bodies, we should know without Trial several of their Operations one upon another, as do we now the Properties of a Square, or a Triangle” (4.3.25). Locke supposes that if we knew the inner constitutions of two bodies, then our grasp of the interactions between those bodies would be something like our grasp of mathematical properties. As I have said, he thinks that if the chemist and the physiologist knew the internal constitutions of bodies, then their methods would be like the methods of the watchmaker and the locksmith. If he intends to imply that the methods of the chemist and physiologist would be like the methods of the mathematician as well, then he may believe that watch making resembles mathematics more than we might have thought.

Edwin McCann suggests that we not take the analogy between mathematicians and artisans to extend to their methods: “What the watchmaker and the geometer have in common is their ability to know, without trial or experiment, what properties the objects of their respective areas of concern have, or what they might be expected to do in certain circumstances.”¹¹ Watchmakers resemble mathematicians in being reliable, but, according to McCann, Locke does not believe that they use the same methods. On McCann’s reading, Locke could have as aptly compared the watchmaker’s knowledge of watches with Isaiah’s knowledge of the future of Israel.

It is hard to reach indisputable conclusions about how far to take a simile. As McCann concedes, Locke frequently compares the relation between the real essence of a body and its derivative properties to the relation between the real definition of a geometrical figure and its derivative properties.¹² Given how often Locke returns to the comparison, we should take it as seriously as reasonability allows.

In order to push the analogy along, let me use a complicated gear example. Suppose that six gears are hooked up in a line so that each touches two others except for the first one and the last one. Suppose the first gear has thirty teeth in it and the sixth one has forty teeth in it. If the first gear makes one complete clockwise rotation, how will the sixth gear rotate? The answer is three-fourths of the way counter-clockwise, by the following reasoning: since every gear moves (if it moves) in the opposite direction of any gear hooked up to it, gears will move in the same direction if they touch a common gear. If the gears are hooked in a line, the first gear will turn in the same direction as the third and fifth gears and in a different direction from the second, fourth, and sixth gears. Thus, if the first gear turns clockwise, the sixth gear turns counter-clockwise.

We can also see that teeth on different gears move at the same rate past the point where the gears meet. So, if thirty teeth of the first gear move past the point of contact between the first and second gear, then thirty teeth of the second gear also move past that point. Since all of the teeth on

a rotating gear move at the same rate, in the time it takes thirty teeth on the second gear to move past the point of contact with the first gear, thirty teeth on the second gear will move past the point of contact with the third gear. Given the way the gears are set up, in the time the thirty teeth of the first gear take to make a complete rotation, thirty teeth of the sixth gear would move past the point of contact between the fifth and the sixth gear. Since the sixth gear has forty teeth in it, it follows that if the first gear makes one revolution clockwise, the sixth gear will make three-fourths of a revolution counter-clockwise. This reasoning is akin to mathematical reasoning.¹³

Locke defines intuitive knowledge as the perception of “the Agreement or Disagreement of two *Ideas* immediately by themselves” (4.2.1). He calls a chain of intuitions a demonstration and believes that we have to appeal to such chains when we cannot immediately perceive the agreement of ideas. So for example,

Because the three Angles of a Triangle cannot be brought at once, and be compared with any other one, or two Angles; and so of this the Mind has no immediate, no intuitive Knowledge. In this Case the Mind is fain to find out some other Angles, to which the three Angles of a Triangle have an Equality; and finding those equal to two right ones, comes to know their Equality to two right ones (4.2.2).

If we may apply this framework to the complicated gear inference, the knowledge that if one gear moves clockwise an adjacent gear moves counter-clockwise counts as an intuition, and the chain of inferences justifying the conclusion that the sixth gear will turn three-fourths of a rotation counter-clockwise counts as a demonstration. I presume that Locke has this sort of inference in mind when he draws an analogy between the watchmaker and the mathematician.

2.2 Five Inexplicable Phenomena

Although he has a good opinion of corpuscularianism, Locke denies that it can explain all phenomena. If we knew the microphysical structure of rhubarb, and opium, we could deduce some

of their features, but not all of them. At 4.3.29, he summarizes a large amount of skeptical argumentation into a single line, telling us that

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 being such, wherein we can discover no natural connexion with any *Ideas* we have, we cannot but ascribe them to the arbitrary Will and good Pleasure of the Wise Architect (4.3.29).

If we split hairs, five inexplicable items make up this telegraphic list: the cohesion of matter, the continuity of matter, the production of sensation, the rules of motion, and the communication of motion.

By cohesion, Locke means, “the parts of Bodies stick firmly together” (2.23.25). As we have seen, he believes that knowing mechanical affections can help to explain corporeal interactions. One of the primary mechanical affections is figure. He reasonably claims that figure derives from extension (2.23.17); in turn, he asserts that the extension of a body depends on the cohesion of its solid parts (2.23.23). Locke argues that explanations end at this point, at least for us. He tries to show that we have no prospect of understanding cohesion.

According to McCann, Locke does not deny that cohesion might be explained mechanically, he merely denies that any contemporary explanation succeeds.¹⁴ However, Locke does declare that “wherein consists the union and cohesion of [the parts of a body] seems to me as incomprehensible, as the manner of Thinking, and how it is performed” (2.23.24), which suggests a more pessimistic outlook.¹⁵

All of Locke’s arguments are indeed against particular accounts of cohesion¹⁶, but we should attend to the form of some of his arguments. In several, he argues that contemporary theories of cohesion, even if true, would not completely explain cohesion. Locke points out that the theory that the evenly distributed pounding of air corpuscles presses macroscopic bodies together

would not explain the coherence of the air corpuscles (2.23.23). He argues that we cannot completely fill in the explanatory gap by supposing that the pressure of the ether holds the corpuscles together, since the coherence of ether particles would remain unexplained (*ibid.*).¹⁷ Finally, he admits that it would be a great discovery if someone determined the cement that holds ice together, but this would not make cohesion “intelligible, till he could shew wherein consisted the union, or consolidation of the parts of those Bonds, or of that Cement, or of the least Particle of Matter that exists” (2.23.26).¹⁸ The same theme runs through all of these arguments: we can give no ultimate account of the cohesion of the bodies that explain the cohesion of other bodies.

This kind of regress argument will not work against any possible explanation of cohesion. One might explain it without appealing to objects that themselves cohere. For example, one could think of the ether not as composed of cohesive particles but as a perfect fluid.¹⁹ Along the same lines, Leibniz believes that matter at rest is such a fluid and (following Hobbes) that the intersecting motions of that fluid produce firmness.²⁰ Someone who explains the cohesion of bodies through the behavior of a fluid does not move in a circle, nor does she use the kind of explanation that artisans apply to machinery.

Today, we think that electrical attraction explains the cohesion of solids. One might either think that this explanation does not involve an appeal to any further solid object, or, as I suppose, that it depends on the cohesion of protons and electrons.

Whether or not modern explanations of cohesion go down to the basement, Locke’s pessimism about our prospects for explaining it indicates his commitment to corpuscularianism. Natural philosophers who restrict themselves to mechanical principles cannot explain cohesion completely. A regress argument will work against any account of cohesion that explains phenomena by appealing to the mechanical affections of bodies in the way that a watchmaker or a smith appeals to them. Extension is too fundamental to this kind of explanation to get around. If the extension of solid

bodies depends on cohesion, there is no hope of offering a mechanical explanation of cohesion without falling into a vicious circle. Cohesion explains the mechanical features of bodies, and these features cannot explain cohesion in turn.

Let me turn from the cohesion of matter to its continuity. Locke does not deal with the problem of the ‘continuity of the parts of matter’ under that title anywhere else in the *Essay*. One might think that he has in mind the problem of the nature of the geometrical relations between the ultimate constituents of matter, since philosophers of the time consider that to be a major stumbling block to reason and occasionally refer to it as a problem of continuity.²¹ Locke does talk a fair amount about that problem and asserts that “the divisibility *in infinitum* of any finite Extension, involv[es] us, whether we grant or deny it, in consequences impossible to be explicated, or made in our apprehensions consistent” (2.23.31).²² (Brian O’Shaughnessey refers to infinite divisibility as “that other infinitude, beloved of Locke”²³.)

Locke argues that we lack a positive idea of infinite divisibility, since we cannot “have a clear and positive *Idea* of that Smalness, which is consequent to infinite Divisibility” (2.17.18, compare 2.29.16, 4.17.10). He concludes that “the great and *inextricable Difficulties*, which perpetually involve all Discourse *concerning Infinity*, whether of Space, Duration, or Divisibility, have been the certain *marks of a defect in our Ideas of Infinity*” (2.17.21, compare 2.23.31). His implication seems to be that we will get straight on these matters when and only when we have a proper idea of infinite divisibility.

Because Locke implies that our difficulties with respect to infinite divisibility result from a defect in our ideas, and not from the nature of the things themselves, it seems to me that he is not talking about infinite divisibility in 4.3.29. First, such a defect would not require an ascription of the infinite divisibility to the ‘arbitrary Will and good Pleasure’ of God. Indeed, it is not clear what such an ascription would mean. Second, it is important to recognize that Locke’s discussion of the

sources of ignorance at the end of 4.3 is explicitly and clearly divided into three parts. In the first part, stretching from section twenty-three to twenty-seven and including Locke's lament that we do not possess ideas of the microphysical structures of hemlock and *aqua regia*, the "want of ideas" produces ignorance. In the second part, comprising sections twenty-eight and twenty-nine, a "Want of discoverable Connexion between the *Ideas* we have" produces ignorance.²⁴ Locke implies that the problem of infinite divisibility would be solved if we had a good idea of the infinitely small consequence of infinite divisibility. If the problem of continuity discussed in 4.3.29 were that very problem, then Locke would have placed his discussion of it with the discussion of ignorance produced by our lack of ideas.

I suspect that the answer lies in the Aristotelian background. Aristotle thinks that the problems of continuity and cohesion are linked, writing, "continuity belongs to things that naturally in virtue of their mutual contact form a unity. And in whatever way that which holds them together is one, so too will the whole be one, e. g. by a rivet or glue or contact or organic union" (*Physics*, 227a14-a16).²⁵ Locke ties the problems together because Aristotle had tied them together. This connection helps clear up a puzzle from Locke's discussion of cohesion: why did he assert that extension presupposes cohesion? As Leibniz observes, "perfectly rarified and fluid matter may be said to make up an extended thing, without its parts being joined to one another."²⁶ Perhaps Locke believes in the impossibility of a genuinely continuous fluid, as opposed to a loose aggregation of sub-microscopic solid particles, and perhaps he believes in that impossibility because he had been trained to think that continuity entailed cohesion.

The third of the inexplicable phenomena is 'the production of Sensation in us of Colours and Sounds, *etc.* by impulse and motion'. This is Locke's paradigm of inexplicability. He asserts that the "mechanical Affections of Bodies" and ideas of secondary qualities have "no affinity at all" with each other (4.3.28). We are therefore forced to reason about them "as effects produced by the ap-

pointment of an infinitely Wise Agent, which perfectly surpass our Comprehensions” (ibid.). The lack of affinity rules out “distinct knowledge of such Operations beyond our Experience [. . .] the *Ideas* of sensible secondary Qualities, which we have in our minds can, by us, be no way deduced from bodily Causes” (ibid.). In whatever manner God brought about the connections between violets and the sensations they produce in us, Locke denies that these connections are discoverable by the methods of the watchmaker or locksmith. Presumably, the watchmaker and the locksmith would be the first to agree.

Locke’s list of inexplicable phenomena ends with ‘the original Rules and Communication of Motion’. For the sake of analytical clarity, let me distinguish the rules of motion (the principles that govern projectile motion and unrestrained collisions) from the communication of motion (the fact that one body can move another body at all). Some colliding objects, for example, billiard balls, are unconstrained in a certain way. As Hume writes of them, “May not both these balls remain at absolute rest? May not first ball return in a straight line, or leap off from the second in any line or direction?”²⁷ The motions of the watchmaker’s gears and the locksmith’s tumblers are forced in a way that the motion of the second billiard ball is not. If a gear turns clockwise then the gears attached to that gear must turn counter-clockwise, on the assumption that they do not melt, vanish, or fly off their posts. They have no place else to go.

A philosopher might argue as follows. The rules of motion depend on the arbitrary will of God, and thus we cannot deduce them. Therefore, we cannot deduce either the course of a body in flight or the result of a collision, since these depend on the rules of motion. Such an argument would not yet cast doubt on the inferences of the watchmaker or the locksmith, not until showing how their inferences rely on the rules of motion.

There is a bit of that in the *Essay*. Locke seems to presume that something like Descartes’s collision laws would be the best candidates for knowable rules of motion. As he notes, however, “the

increase of Motion by impulse [. . .] is observed or believed sometimes to happen” (2.23.28). Locke does not explain what he means by ‘the increase of Motion’, but according to Descartes’s laws (and not according to the modern law for elastic collisions) a struck body cannot end up traveling faster than the striking object’s initial speed.²⁸ Alternatively, he may be referring to what Descartes calls the quantity of motion, the product of size and speed.²⁹

For the most part, Locke does not argue in that way. He feels pushed to understand the transfer of motion with the help of the scholastic notion of a real accident. He cannot help thinking that collisions involve the passing of an accident, motion, from one body to another, since “we have no other conception [of it], but of the passing of Motion out of one Body into another” (ibid.). Since this evokes the transfer of real qualities from one substance to another, he calls this “as obscure and inconceivable, as how our Minds move or stop our Bodies by Thought” (ibid.).

A scholastic real quality inheres in a substance but does not entirely depend upon that substance for its existence and may jump to another substance. Scholastics had appealed to real qualities to describe light and the Eucharist, but not, as a matter of fact, to describe the transfer of motion.³⁰ Locke’s inclination to treat the transfer of motion as the transfer of a real quality places him in an awkward position, however, since early modern philosophers treated real qualities as paradigms of scholastic obfuscation. For example Descartes argues in the *Principles of Philosophy* that “there is no way of understanding how these same attributes (size, shape, and motion) can produce something else whose nature is quite different from their own—like the substantial forms and real qualities which many suppose to inhere in things”³¹. Henry More writes Descartes that the collision laws in the *Principles* describe the transfer of motion from one body to another, and thus implicitly commits Descartes to treating motion as a real quality. Descartes replies,

You observe correctly that ‘motion, being a mode of body, cannot pass from one body to another’. But that is not what I wrote [. . .] When I said that the same amount of motion always remains in matter, I meant this about the force which im-

pels its parts, which is applied at different times to different parts of matter in accordance with the laws set out in articles 45 and following of Part Two. So there is no need for you to worry about the transmigration of rest from one object to another, since not even motion, considered as a mode which is the contrary to rest, transmigrates in that fashion.³²

This is an important, yet enigmatic remark, one that does not satisfy all subsequent thinkers. The problem pushes Margaret Cavendish to assimilate the collisions of bodies to the control of the mind over the body, and to the conclusion that all matter is animated.³³ Leibniz expresses surprise at Locke's sympathy for the view that motion is a real quality that can move from body to body. He has Theophilus tell Philalethes, "I doubt that this is your view, or that of your able friends, who usually stay well clear of such fantasies."³⁴ In this context, Locke calls the transfer of motion in collisions "obscure and inconceivable".

2.3 Wilson's Puzzle

In the previous section, we have been bumping against what Margaret Wilson calls the "Limits of Mechanism in Locke"³⁵. She raises the puzzle of how his geometrical analogies can fit within these limits. As I have said, Locke frequently asserts that the properties of a body can be derived from its real essence in the same way that the properties of a geometrical figure can be derived from its definition. He sets forth these analogies without hesitation, qualification, or argument, as if he thinks that no one will dispute what he is saying. In addition, he presumes that the real essence of a body "can be nothing but the Figure, Size, and Connexion of its solid Parts" (2.31.6), what he calls 'mechanical affections' at 4.3.25. How can we make Locke's geometrical analogies compatible with his arguments that some phenomena have no mechanical explanation?

There are difficulties here, but I submit that they are not what they are commonly taken to be. Michael Ayers presents the key to resolving these contradictions in response to Wilson. He points out that there is a scholastic use of the word 'property' according to which "*properties* are,

roughly speaking, attributes characteristic of a species or genus which necessarily or at least naturally belong to all its members, and which are explained by, or flow from, its essence.”³⁶ Ayers’s disjunction allows that properties may either belong naturally or necessarily to their subjects. Contemporary definitions sometimes required necessity. For example, following Porphyry’s four definitions of ‘ιδιον’,³⁷ the Port-Royal logicians offer four definitions for ‘[look up]’. The first runs as follows:

When we have found the difference constituting a species, that is, the principal essential attribute that distinguishes it from all other species, if, considering its nature in more detail, we find yet another attribute necessarily connected to this primary attribute, that therefore applies to all and only this species, *omni et soli*, we call it a property.³⁸

Of the four, this definition is closest to the one that Aristotle gives for ‘ιδιον’ at *Topics*, 1.5. The second definition is like the first, except it allows that members of other species may also possess the feature. I suggest that Locke uses something like this second sense of ‘property’ in his mathematical analogies.

In my opinion, Ayers has not properly exploited his linguistic insight. It is a remarkable fact that if Locke is using the word ‘property’ in either of the first two Port-Royalist senses, then many statements that seem to be startling rationalist dogmas turn out to be tautologies. Recall 2.31.6.

There he argues that one of our complex ideas

cannot be the real Essence of any Substance; for then the Properties we discover in that Body, would depend on that complex *Idea*, and be deducible from it, and their necessary connexion with it be known, as all Properties of a Triangle, depend on, and as far as they are discoverable, are deducible from the complex *Idea* of three Lines, including a Space.

Suppose that in this passage Locke uses the word ‘property’ to mean ‘feature derivable from a real essence with mathematical necessity’. He would be asserting that if a complex idea of a substance

were the real essence of that substance, then any feature that can be derived with mathematical necessity from that real essence could be derived from that idea.

If ‘property’ just means, ‘feature derivable from a real essence with mathematical necessity’, then, of course, the properties of a thing are derivable from real essences with mathematical necessity. It does not follow that cohesion, continuity, producing sensations, obeying the rules of motion, and communicating motion can be thus derived, since it does not follow that these features are properties in the relevant sense. I conclude then that Locke’s arguments that some phenomena cannot be explained through mechanical inferences do not contradict his geometrical analogies. Some of the features of gears, locks, rhubarb, and opium might be demonstrable from their real essences, but he is not committed to saying that all of their features are thus derivable.

Although Locke’s skeptical worries about the five inexplicable phenomena do not contradict his comparison between mathematical inferences and mechanical inferences, they do undermine the comparison. More precisely, they undermine the analogy between mathematical inferences and *applied* mechanical inferences.

2.4 The Epistemic Status of Applied Mechanical Inference

The six-gear inference I described above involved ideal gears, ones for which certain practical questions do not arise. When we attempt to apply conclusions about ideal gears to particular material gears—made of copper, greased with oil—we will do it by judging that the actual gears behave in the same way. Because he has high standards for knowledge, Locke is committed to denying that such applied inferences provide us with knowledge, strictly so-called. As Downing remarks, “we cannot deduce the key’s ability to open the lock from the shape of the key and the shape of the lock if the key might crumble or the pressure from the key might fail to move the lock.”³⁹ Since we have no explanation of the foundations of cohesion, our only reason for believing that an actual gear will

continue to cohere is past experience. (Remarks parallel to those that follow can be made with respect to the communication of motion.)

Locke would probably classify the assumption that particular gears will cohere throughout their turning as ‘assurance’, the highest degree of certainty that does not count as knowledge. He tells us that everyone agrees as a matter of experience that “Fire warmed a man, made Lead fluid, and changed the colour or consistency in Wood or Charcoal; that Iron sunk in Water, and swam in Quicksilver” (4.16.6). From this universal agreement, “we are put past doubt, that a relation affirming any such thing to have been, or any predication that it will happen again in the same manner, is very true” (ibid.). As a practical matter, he assures us,

these Probabilities rise so near to Certainty, that they govern our Thoughts as absolutely, and influence all our Actions as fully, as the most evident demonstration: and in what concerns us, we make little or no difference between them and certain Knowledge: our belief thus grounded, rises to Assurance (ibid.).

Locke emphasizes that, practically speaking, judgments such as *iron will sink in water* are as good as knowledge. I emphasize that, theoretically speaking, he refuses to call such judgments certain knowledge. He withholds this compliment because, as I said, he has very high standards for counting something as knowledge. At 4.3.29 he asserts that “we are only capable of certain and universal knowledge” when the relevant “Relations, Habitues, and Connexions [are] so visibly included in the Nature of the *Ideas* themselves, that we cannot conceive them separable from them, by any Power whatsoever.” This means that a prediction only will count as certain and universal knowledge if we cannot conceive that any agent, natural or supernatural, might make the prediction false. We can conceive of God’s frustrating the prediction that iron will sink in water. Thus, that and similar predictions cannot count as knowledge by Locke’s standards.

The watchmaker’s confidence that a copper gear will not melt when spun has the same epistemic status as the prediction that iron will sink when placed in water. Locke must believe that we

can conceive of God's frustrating the prediction that a gear will cohere while a gear next to it is turned, especially since he believes that we must attribute the coherence of matter to God's will.⁴⁰ He must therefore deny that applied gear inferences provide us with knowledge in the strict and philosophical sense.

Locke implies that we cannot perceive a necessary connection between the motion of one gear and the motion of another. It is true, as we will see, that he believes that we can see causal interactions. Nevertheless, this is not the same thing as saying that we perceive that if the first gear moves clockwise, the second one must move counter-clockwise.⁴¹ If we put a loud and philosophical emphasis on the 'must' and take seriously the possibility of melting, we will see that we perceive no such thing. If we concede that, for all we know, the gears could melt, then it does not make much sense to say that we perceive that the second gear absolutely must move in the opposite direction from the first.

None of Locke's skeptical reflections contradicts his belief that watchmakers understand their watches well by using deductive reasoning, since he believes in deductive explanations that are not ultimate and complete explanations. Locke believes that the watchmaker has an explanation for the rotation of the second gear, although he also believes that she does not understand why the gears do not melt. Surely, this is right. The watchmaker has a superior understanding of watches, and this superior understanding consists in the fact that she can offer better deductions of how watches work than most people can. This is true even if she cannot go further down the chain of explanations and explain why copper or any other solid material does not melt upon contact.

3. THE INCONCEIVABILITY OF ALTERNATIVES TO CORPUSCULARIANISM

3.1 Explanation with Inconceivable Foundations

No one doubts that gears work mechanically. It is not so obvious that opium and rhubarb do. Locke calls corpuscularianism the hypothesis "which is thought to go farthest in an intelligible

Explication of the Qualities of bodies” (4.3.16). One might doubt that Locke himself thinks that corpuscularianism goes farthest in intelligibly explaining the qualities of bodies. As we have seen, he argues that we cannot explain the cohesion of matter and the communication of motion, two foundations of the corpuscularian world. Notwithstanding those arguments, Locke believes that corpuscularianism is uniquely intelligible. I want to defend the consistency of Locke’s position, to explain the epistemic status of that intelligibility, and to examine its psychological genesis.

Downing takes Locke’s skeptical arguments to show that he does not believe in corpuscularianism. Against the almost universal consensus of commentators⁴², she argues that we should take Locke’s references to corpuscularianism hypothetically, as mere illustrations of conceptual distinctions.⁴³ On her reading, Locke believes that the skeptical problems he raises about the foundations of corpuscularianism leave “us with no special reason to assume that it’s true”⁴⁴.

One could move two ways from Locke’s remarks about the inconceivability of explaining cohesion and the communication of motion to the conclusion that Locke does not believe in corpuscularianism. The first way is obviously mistaken, the second, less obviously so.

The first way is to say that since Locke believes that the grounds of cohesion and impulse are in some sense inconceivable, he believes that there is neither cohesion nor impulse in the world, and thus *a fortiori* that corpuscularianism is false. If we step back and look at Locke’s purposes in making skeptical remarks about cohesion and impulse, we can see that this reading get him wrong. In the sections beginning at 2.23.22, Locke offers a *tu quoque* argument against materialists who argue against dualism because of the obscurities surrounding the soul: fundamental facts about bodies are just as obscure. Locke does not deny that bodies cohere; he denies that we can explain coherence: “The matter of Fact is clear,” he writes, “but when we would a little nearer look into it, and consider how it its done, there, I think, we are at a loss” (2.23.25). He sums up his skeptical remarks about impulse by writing, “We have by daily experience clear evidence of Motion produced both by im-

pulse, and by thought; but the manner how, hardly comes within our comprehension” (2.23.28).

He grants that bodies cohere and knock each other about; he denies that we comprehend ‘the manner how’.

There is a second, more plausible way to move from Locke’s skeptical comments to the conclusion that he does not believe in corpuscularianism. According to this line of thought, his only reason to believe in corpuscularianism is its explanatory force. Since corpuscularian explanations of phenomena necessarily appeal to impulse, and the explanation of impulse is mysterious, he cannot think that corpuscularianism is any more likely to be true than scholasticism, neo-Platonism, or magic.

It is a mistake to think that Locke consider appeals to impulse no better than appeals to any other form of explanation. The fourth edition version of 2.8.11 runs, “the next thing to be consider’d, is how *Bodies* produce *Ideas* in us, and that is manifestly *by impulse*, the only way which we can conceive *Bodies* operate in.” He develops a corpuscularian theory of perception in the following three sections upon the premise that the bodies that we perceive affect our senses only through impulse, directly or indirectly. Most importantly, he argues that since the primary qualities of bodies “may be perceived at a distance *by* the sight, ‘tis evident some singly imperceptible *Bodies* must come from them to the Eyes” (2.8.12). From his corpuscularian theory of perception, he draws the further conclusion that ideas of primary qualities resemble something in bodies and ideas of secondary qualities do not (2.8.15).⁴⁵

A lot hangs on the unique conceivability of impulse as a corporeal force. Locke is willing to base a corpuscularian theory of perception on this premise and is willing to draw further consequences from this theory. Downing is right to point out that most of his references to corpuscularianism are illustrative or hypothetical⁴⁶, but here he is categorical. When Locke describes secondary

qualities of bodies as “depending all (as has been shewn) upon the primary Qualities of their minute and insensible parts”⁴⁷ (4.3.11), the showing he refers to occurs in 2.8.11 and what follows.

How can Locke’s conclusion in 2.23.28 that we do not comprehend “the manner how” motion is produced by impulse cohere with his assertion in 2.8.11 that we can only conceive of bodies operating through impulse? We can see the consistency of these passages by recognizing that Locke believes that we can explain phenomena through principles that we cannot explain in turn. At 2.23.28 impulse is a phenomenon to be explained, and, since it seems to involve the transfer of real accidents from one body to another, he concludes that we have no explanation for it or any prospect of acquiring one. At 2.8.11, the phenomenon to be explained is the motion of bodies, something distinct from impulse. In the first search for explanation, we cannot appeal to impulse on pain of circularity. In the second search, Locke assumes that an appeal to impulse will be intelligible and helpful.

Some might say we should not use impulse explanations to explain phenomena until we understand impulse all the way down, but this seems excessively scrupulous.⁴⁸ We should not suppose that difficulties in conceptualizing the transfer of motion show that locksmiths cannot explain how a key opens a lock. If Locke’s worries about the conceptualization of impulse do not imperil the locksmith’s actual explanations of how a key opens a lock, they do not imperil the corpuscularian chemist’s potential explanation of how *aqua regia* dissolves gold. If a pharmacist somehow learns the minute mechanical affections of opium and the human body, and thereby derives the soporific effects of opium, we will not complain if he fails to give an ultimate explanation of cohesion of poppy seeds.

3.2 The Epistemic Status of Inconceivability

At 4.3.16, Locke calls corpuscularianism a “Hypothesis”, the hypothesis “which is thought to go farthest in an intelligible Explication of the Qualities of Bodies” but a hypothesis nonetheless. If his reasons for believing that natural bodies work mechanically were exhausted by his analogies

and by the deductive virtues of mechanical explanation, the hypothetical status of corpuscularianism would be unsurprising; Locke himself observes that analogies merely justify a low grade of probable belief (4.16.12).

As we have seen, however, Locke also believes that impulse is “the only way which we can conceive Bodies operate in” (2.8.11, 4th edition). One might think that this premise suffices to make corpuscularianism certain. I believe that this thought rests on a misunderstanding of the relevant conceivability. In this section, I will argue that though Locke believes that we can only conceive of bodies’ interacting through impulse, he also believes that other forms of corporeal interaction are possible and, indeed, actual. The relevant inconceivability is merely psychological and not a guarantee of falsehood. It justifies with probability and not with certainty.

Let me defend these assertions by examining the way 2.8.11 stands in the first edition of the *Essay* and the way that Locke revises that section. In the first edition, he states, “Bodies operate one upon another [. . .] by impulse, and nothing else.” He justifies this statement by arguing that it is “impossible to conceive, that Body should operate on what it does not touch, (which is all one as to imagine it can operate where it is not) or when it does touch, operate any other way than by Motion.” In short, the interaction between bodies is by impulse, because the alternatives are inconceivable.

In reconstructing the argument I recommend setting aside his parenthetical remark that nothing can operate where it is not, since the remark is ambiguous, and either sophistical or rhetorical. Suppose that X operates on Y. Locke can be denying one of two possibilities by denying that X can operate where it is not. The first is that X is operating and is not where X is. The second is that X is operating and is not where Y is. On the first reading, the denial is true but does not lend support to the conclusion. On the second reading, Locke begs the question. He may intend the first reading and mean only to emphasize the inconceivability of action at a distance; we might read the

comment as the rhetorical equivalent of asserting “one might as well say that pigs can fly.” Whatever Locke means by the remark, he decides to withhold it in the fourth edition.

Setting aside Locke’s parenthetical paralogsism, we can see that the real work in this argument is being done by the following principle: if there is only one conceivable explanation for a phenomenon, then we may infer that the explanation is right. On his assumptions, this rule suffices to justify both the proposition that all corporeal interactions are by contact and the proposition that all corporeal interactions are by motion.

I deny that Locke relies upon the following, stronger inference rule: if something is inconceivable, then we perceive its impossibility. He explicitly rejects the consequence of that rule that if something is inconceivable, then it is false. For example, he acknowledges that thinking matter is inconceivable, but claims that the alternative of mind-body interaction is just as inconceivable. He protests against “an unfair way which some Men take with themselves: who, because of the unconceivableness of something they find in one, throw themselves violently into the contrary Hypothesis, though altogether as unintelligible to an unbiased Understanding” (4.3.6). On Locke’s view, there are situations in which both a hypothesis and its contrary are inconceivable; thus, he must believe that some truths are inconceivable.⁴⁹ We have already seen that he believes that cohesion and impulse are both actual and impossible to explain. For Locke, the limits of the world not only go beyond the limits of our knowledge, they go beyond the limits of our conceptions (1.1.5, 2.2.3).

Locke’s belief in the actuality of the inconceivable manifests itself in some second thoughts he has about his original conclusion that all corporeal interactions occur through impulse. He revealed his change of heart in his second reply to Stillingfleet:

It is true, I say, “that bodies operate by impulse, and nothing else” [footnote: *Essay*, b. ii. c. 8 § 11]. And so I thought when I writ it, and can yet conceive no other way of their operation. But I am since convinced by the judicious Mr. Newton’s incomparable book, that it is too bold a presumption to limit God’s power, in this point, by

my narrow conceptions. The gravitation of matter towards matter, by ways inconceivable to me, is not only a demonstration that God can, if he pleases, put into bodies powers and ways of operation above what can be derived from our idea of body, or can be explained by what we know of matter, but also an unquestionable and every where visible instance, that he has done so. And therefore in the next edition of my book I shall take care to have that passage rectified.⁵⁰

Though he does not abandon his claim that the only way we can conceive of bodies interacting is by impulse, Locke is now convinced that God put gravitational attraction into bodies so that they operate in an inconceivable way. Newton himself can be cagey about whether there could be a mechanistic explanation for gravity⁵¹, but Locke reasonably enough considers the *Principia* to show that not all interactions between bodies are by impulse.⁵²

Leibniz objects to Locke's proposed revision on the grounds that appeals to the divine power undermine the fight against scholasticism,

for, with the aid of 'what God can do', we may give too much leeway to bad philosophy by admitting these 'centripetal powers' and 'immediate attractions' at a distance, without being able to make them intelligible; I do not see what is to prevent our Scholastics from saying that everything simply comes about through 'faculties', and from promoting their 'intentional species' which travel from objects to us and find their way into our souls. If that is acceptable, 'Everything will now happen whose possibility I used to deny.'⁵³

As Leibniz sees it, one cannot reject scholastic theories because their explanations of phenomena are unintelligible and believe at the same time that gravity works in an unintelligible way. For him, accepting action at a distance would have meant the end of sound philosophy, since it would neutralize the chief weapon in modern philosophy's arsenal, its intelligibility.

Locke's actual revision shows that he does not believe that there is any inconsistency in believing in action at a distance and rejecting scholastic theories of perception on the grounds of their inconceivability. He deletes the offending section in the fourth edition and the replacement passage

runs as follows: “The next thing to be consider’d, is how Bodies produce Ideas in us, and that is manifestly by impulse, the only way which we can conceive Bodies operate in.” Locke still argues that since the only conceivable way that bodies interact is by impulse, they must therefore interact by impulse when they produce ideas in us. To the extent that he fulfills his promise of making the passage consistent with his understanding of gravity, he does it merely by restricting the subject under discussion to the physics of perception.

Locke believes in the existence of inconceivable phenomena while rejecting the scholastic theory of perception for its inconceivability. Evidently, he holds a moderate opinion of the epistemic status of conceivability. According to him, the conceivability of a hypothesis and the inconceivability of alternatives provide us with good grounds to believe the conceivable hypothesis. These grounds are not utterly conclusive and other considerations can override them—for example, the lessons that Locke draws from Newton’s work. On this view, conceivability is a guide to truth, but a fallible one.

Given his emphasis on our cognitive limits, we can see why Locke believes that the true theory might be inconceivable. After calling corpuscularianism a hypothesis, he remarks that he “fear[s] the Weakness of humane Understanding is scarce able to substitute another, which will afford us a fuller and clearer discovery of the necessary Connexion, and *Co-existence*, of the Powers, which are to be observed united in several sorts of [bodies]” (4.3.16). Mechanical explanations of nature may be merely probable, but Locke does not believe that we can substitute alternative forms of conceivable explanation. If corpuscularianism is false, we will not find a better theory with different, conceivable forms of interaction. According to him, if corpuscularianism is false, then we cannot really comprehend how the world works.

One might ask whether we should put any epistemic weight on this psychological inconceivability. Given what Locke means by inconceivability, why is the inconceivability of its alternatives

any evidence at all for the truth of corpuscularianism? Let me defer this question until I have said a little about the origin of the inconceivability.

3.3 The Source of Conceivability

Locke's belief in the unique intelligibility of impulse requires an explanation. Recall Newton's work does not convince him that he can conceive of bodies interacting in any way besides impulse. He asserts this even though he believes that impulse is completely inexplicable. Why does Locke imply that impulse does, and gravity does not, provide us with a conceivable account of the interactions of bodies?

The answer is a piece of pure empiricism. As Ruth Mattern has argued, Locke believes that we can experience impulse interactions between bodies.⁵⁴ Recall that Locke sums up his skeptical remarks about impulse by writing, "We have by daily experience clear evidence of Motion produced both by impulse, and by thought; but the manner how, hardly comes within our comprehension" (2.23.28). He believes both that impulse produces motion and that we know this by experience. Another text that implies that Locke believes that we can observe the transfer of motion from one body to another occurs in 2.21.4, where he says of a billiard ball, "we observe it only to transfer, but not to produce any motion" (2.21.4).

So Locke tells us that we perceive the transfer of motion from one body to another and in the same breath he asserts that "the manner how, hardly comes within our comprehension". We perceive the phenomenon without having any explanation for it. There is no tension here. To take an example from Locke's "Discourse on Miracles", the disciples may perceive Jesus' walking on water without comprehending the manner in which it is done.⁵⁵ In natural cases as well (the northern lights, the flight of the bumblebee), a person may perceive what he cannot explain.

Thus, Locke believes that we can perceive impulse interactions between bodies. I say that he believes that these are the only perceptible causal interactions between bodies. Thus, given his theory of idea acquisition, they are the only conceivable causal interactions between bodies.

Consider his closely related thesis that the conceivable actions of bodies are “nothing else but Modifications of Motion” (2.22.11). I take this to be the general version of the thesis that all corporeal interactions are by impulse. Interactions are a species of action (when a body moves freely, it acts, but it does not interact) and impulse is a way in which motion can be modified. According to Locke, words that seem to signify other sorts of corporeal actions besides motion “signify nothing of the Action, or *Modus Operandi* at all, but barely *the effect*, with some circumstances of the Subject wrought on, or Cause operating” (ibid.). From the examples he gives—‘creation’, ‘annihilation’, and ‘freezing’—we may infer that he thinks of interaction as a species of action and that he believes that conceivable interactions between bodies only involve varieties of motion. To illustrate his point, he asserts that

when a Country-man says, the Cold freezes Water, though the word Freezing seems to import some *Action*, yet truly it signifies nothing, but the effect, *viz.* that Water, that was before fluid, is become hard and consistent, without containing any *Idea* of the Action whereby it is done (ibid.).

I suggest that Locke believes that the only conceivable corporeal actions are modifications of motion because he does not believe that we can experience other kinds of corporeal action. The villager observes that it is cold and that the water is now hard, but ‘freezing’ does not refer to an activity that he has witnessed. In contrast, motion is a conceivable action of bodies because we can perceive the motion of bodies.

Locke draws an analogy that confirms this reading. He tells us that other forms of corporeal action besides modifications of motion are “as much in the dark to me as five other Senses, or as the Ideas of Colours to a blind man” (ibid.). He does not suppose that the blind perceive the im-

possibility of colors or that reason forces them to deny that there are colors. Rather, he believes that since they cannot see, they have no experience of colors, and thus they cannot conceive of colors. Likewise, he believes that no human has experience of bodies acting in any way other than moving.

Locke denies that we can conceive of corporeal interactions beyond impulse for the same reason that he denies that we can conceive of corporeal actions beyond motion. Recall that he argues in the first edition that all interactions between bodies are by contact and we can only conceive of these connections as occurring through motion. Since he believes that these subconclusions suffice to show that “Bodies operate one upon another [. . .] by impulse, and nothing else”, he must consider impulse to be interaction of two contiguous bodies through motion. Impulse is the form of motion by which one body acts upon another. We have not perceived other kinds of corporeal interactions, and thus we cannot conceive of them. When cold air freezes water, we only see solid water.

Some, following Hume, will deny that we can actually observe one body pushing another body. I am more inclined to call into question the thesis that the only experience we have of the activities of bodies is of their motion. After all, we can see a light flashing and hear a telephone ringing.⁵⁶ Given Locke’s opinion that our cognition of the flashing of the light and the ringing of the phone is just our awareness that certain ideas are produced in us, he might well deny that we perceive an action here instead of a mere effect. I will not press the point.

Locke reasons from the premises that all experienced corporeal action is motion and that all interaction between bodies occurs by contact to the conclusion that all experienced connection between bodies is by impulse. Here, too, we may be skeptical. After all, we can observe two liquids mixing with each other, or a person soaking a donut in coffee, and not come away with any experience of an interaction by impulse. Though these actions are in some sense motions, the result does

not visibly come about by a push. When we observe a flame consuming a match, the action of the fire is not even a form of motion, let alone a form of impulse.

Even so, we should not despise Locke's opinion that we observe impulse but not gravitational attraction. Albert Michotte has run psychological experiments in which subjects view the motion of colored geometrical figures against a uniform background. In one experiment "the observers see object A bump into object B, and send it off (or 'launch' it), shove it forward, set it in motion, give it a push."⁵⁷ In contrast, Michotte declares that "it actually seems impossible to produce any causal impression whatever" when two figures are made to move towards one another.⁵⁸

Of course, we can witness an object falling. However, phenomenologically speaking, seeing a thing fall is not the same as seeing the earth pull on it. We do not see the earth pull in the way that we see billiard balls knock. The difference between gravity and impulse that makes Locke assert that only the operation of the second is conceivable is not a matter of mathematics, necessity, or reliability. It is a matter of psychology.

Insofar as this inconceivability justifies, it certainly does not give us knowledge by Lockean standards. Recall that he believes that when we know something, we perceive a connection between two ideas. For universal propositions, this gives us certain knowledge, knowledge that no agent could make false. Thus, when we perceive this sort of agreement between ideas, we recognize the impossibility of the opposite. The inconceivability of alternatives to impulse does not allow us to attain this level of certainty; Locke believes that God actually and unquestionably made bodies operate in different ways. Rather, the alternatives are inconceivable merely because we lack the ideas needed to contemplate them properly.

I should return to the difficulty I raised earlier. On Locke's treatment, the inconceivability of alternatives to impulse is a mere psychological inconceivability. Some might deny that the visibility of impulse has epistemic weight and establishes a presumption for impulse explanation. Since it

is a mere matter of psychology that we perceive pushes upon contact but not pulls at a distance, they might argue that we should treat this psychological fact as a hindrance to be overcome and not as evidence to be weighed. As Matthew Stuart remarks, “it is rather faint praise to say that what prevents [corpuscularianism] from being supplanted by rival theories is the weakness of our minds.”⁵⁹

Of course, in any inference to the best explanation, the conclusion rests upon the fact that we are unable to think of anything better. Moreover, Locke considers that corpuscularianism attractive in its own right. First, we can cast some mechanical inferences in demonstrative form, as the indirect comparison between the mathematician and the watchmaker suggests. Second, he draws our attention to analogies between the problems of physiology and chemistry and the problems of machinery that artisans know how to solve. Third, ordinary experience establishes impulse as an explanatory principle out in the world. Impulse explanation is a kind of explanation that people use rigorously, successfully, and with the illumination of experience. Given that this form of explanation is legitimate, we should not gratuitously multiply explanatory principles.

The perceptibility of impulse is a contingent matter of psychology. Even so, perceptibility breeds familiarity, inference, and utility. *Ceteris paribus*, it is rational to prefer adopting a successful mode of explanation to hypothesizing a new one. Thus, Locke justifiably advances a false corpuscularian optics, although he recognizes that an alternative theory, appealing to unperceived and unperceived forces, might be true.

An objector might complain that I have changed topics. We were worried about how a mere psychological limitation could justify a doctrine, and I explained how Locke could reply that certain objective epistemic justifications are discoverable within those limitations. That does not show that psychological inconceivability itself justifies a conclusion in natural philosophy. I concede that the weakness of our minds, on its own, without any help, cannot itself justify conclusions in

natural philosophy. To the extent that Locke's argument assumes that it does, the argument is a weak one.

Let me close with a puzzle I do not know how to solve.⁶⁰ At 4.10.19, Locke writes that
We cannot conceive how any thing but impulse of Body can move Body; and yet that is not a Reason sufficient to make us deny it possible, against the constant Experience, we have of it in our selves, in all our voluntary Motions, which are produced in us only by the free Action or Thought of our own Minds.

Here he asserts that we can conceive of impulse moving bodies in a way that we cannot conceive of thought moving bodies. However, it is not clear what that way might be. After all, recall that Locke has previously written, "we have by daily experience clear evidence of Motion produced both by impulse, and by thought; but the manner how, hardly comes within our comprehension" (2.23.28). He emphasizes the equality of the mystery, adding, "we are equally at a loss in both" (*ibid.*). Perception, which makes impulse more conceivable than gravitation, does not help us differentiate impulse from voluntary motion, since Locke emphasizes in both 2.23.28 and 4.10.19 that the production of motion by thought is a matter of experience. Moreover, one might think that any exegetical attempt to set impulse above voluntary motion would contradict Locke's statement that "we are equally at a loss in both".

In any case, it is worth thinking about what respects, if any, impulse is more intelligible than voluntary motion and in what respects, if any, it is equally mysterious. Not so much to make 2.23.28 and 4.10.19 consistent, but because these are interesting philosophical questions.⁶¹

¹ Part of this understanding, a part that I will not be discussing, rests upon the fact that "the Artificer design'd the artifact and "fashions [it] in matter" (3.6.40). For a very good discussion of Locke's place in the "maker's knowledge" tradition, see James Tully, *A Discourse on Property: John Locke and his adversaries*, (Cambridge, 1980), pp. 22-27.

² In principle, at least, corpuscularianism relies on mechanical inference as its main explanatory tool. As a matter of practice, Alan Chalmers has argued that "it was precisely because Boyle forsook the dictates of the mechanical philoso-

phy and invoked more empirically grounded notions such as elasticity and weight that he was able to make headway with his experimental programme” (“The Lack of Excellency of Boyle’s Mechanical Philosophy,” *Studies in the History and Philosophy of Science*, 24 (1993): 541-564, p. 558). My definition of corpuscularianism suffices for my purposes.

³References to the *Essay* are to P. H. Nidditch’s edition (Oxford, 1975).

⁴“The Origin of Forms and Qualities,” *Selected Philosophical Papers of Robert Boyle*, edited with an introduction by M. A. Stewart (Indianapolis, 1991), p. 17.

⁵We may pardon Locke for not coming up with a mechanical analog to rhubarb.

⁶Chalmers complains that this assumption is groundless and misleading in “The Lack of Excellency,” p. 550.

⁷Though “such an acute Sight would not serve to conduct [its possessor] to the Market and Exchange” (2.23.12).

⁸This is one of the most well plowed fields in recent Locke scholarship. See: Margaret Wilson, “Superadded Properties: The Limits of Mechanism in Locke,” *American Philosophical Quarterly* 16 (1979): 143-150, Michael Ayers “Mechanism, Superaddition, and the Proof of God’s Existence in Locke’s Essay”, *The Philosophical Review* 90 (1981): 210-251; Wilson, “Superadded Properties: A Reply to M. R. Ayers,” *The Philosophical Review* 91 (1982): 247-252; “Lockean Mechanism” in *Philosophy: Its History and Historiography*, edited by A. J. Holland (Dordrecht, 1983); Milton, “Lockean Mechanism: A Comment” in the same volume; *Locke* (London, 1991), vol. 2, chapter 12; McCann, “Locke’s Philosophy of Body,” in *The Cambridge Companion to Locke*, edited by Vere Chappell (Cambridge, 1994), §3; “Locke’s Geometrical Analogy”, *History of Philosophy Quarterly* 13 (1996): 451-467; Ayers, review of *The Cambridge Companion to Locke*, *The Locke Newsletter* 28 (1997): 157-189, pp. 162-64; Struan Jacobs and Allan McNeish, “Locke, McCann, and Voluntarism”, *Pa-cific Philosophical Quarterly* 78 (1997): 349-362; Stuart, “Locke on Superaddition and Mechanism,” *British Journal for the History of Philosophy* 6 (1998): 351-79; and Lisa Downing, “The Status of Mechanism in Locke’s *Essay*,” *The Philosophical Review* 107 (1998): 381-414.

⁹“Status of Mechanism”, p. 401

¹⁰Jonathan Bennett argues that Locke ought to say that the inseparability of primary qualities is analytic, and grouses that “Locke has a good point here, but he ought not to express it as though it were a prediction about the outcome of an experiment, for really it is a point about the meaning of the word ‘body’ or about the concept of a body or a physical thing” (*Locke, Berkeley, Hume: Central Themes*, Oxford, 1971, p. 90). Perhaps Locke and Bennett have different abstract ideas of body. In any case, Locke’s point in 2.8.9 is not that if we removed the primary qualities from a grain of wheat

with a pestle, we would no longer call the result a body. Rather, the point is that we cannot remove primary qualities with a pestle. How we classify the resulting flour is neither here nor there.

¹¹“Lockean Mechanism”, p. 222

¹²At, e. g., 2.31.6, 3.3.17, 3.6.8, 3.11.23, 4.3.25, and 4.6.11

¹³ Compare the above inference with the following one described in the Port Royal Logic: “when someone has concluded by reasoning that the iron axle that goes through two grindstones of a mill could turn without making the one below turn if, being round, it went through a round hole; but that it could not turn without making the one above turn if, being square, it were embedded in a square hole in the upper stone, the claimed effect follows infallibly.” (Antoine Arnauld and Pierre Nicole, *Logic or the Art of Thinking*, translated and edited by Jill Vance Buroker, Cambridge, 1996, p. 28) Michael Ayers discusses Arnauld and Nicole’s analogy in *Locke*, vol. 2, p. 135.

¹⁴“Lockean Mechanism”, p. 210. In his remarks on McCann’s paper, J. R. Milton concurs, “Lockean Mechanism: A Comment”, p. 234.

¹⁵ Michael Ayers takes the problem seriously. According to him, Locke believes that “the difficulties at the heart of [corpuscularianism], above all the difficulty of cohesion, point to its not being a full account of the nature of things.” “Mechanism, Superaddition, and God”, p. 222. See also Downing, “Status of Mechanism,” pp. 407f.

¹⁶For the background to Locke’s discussion, see E. C. Millington, “Theories of Cohesion in the Seventeenth Century,” *Annals of Science* 5 (1945): 253-269.

¹⁷ Malebranche (in *The Search after Truth*) and Jacob Bernoulli (in his *Dissertatio de Gravitate Aetheris*) advocate such theories. See Millington, “Cohesion”, pp. 264-67. In the English draft of the abstract of the *Essay*, Locke attributes the view to Bernoulli, *The Life of John Locke*, by Peter, Lord King (London, 1830), vol. 2, p. 250.

¹⁸Malebranche offers a similar argument against explaining cohesion by internal bonds in *The Search After Truth*, edited and translated by Thomas Lennon and Paul Olscamp (Columbus, 1980), p. 512.

¹⁹Locke criticizes ethereal accounts of cohesion on independent grounds at 2.23.24, 27.

²⁰See Leibniz’s “Critical Thoughts on the General Part of the Principles of Descartes” in *Philosophical Papers and Letters*, second edition, translated and edited by Leroy Loemker. (Dordrecht, 1969) Millington traces Leibniz’s debt to Hobbes, “Cohesion”, pp. 262-4.

²¹ Leibniz in the *Theodicy*, “There are two famous labyrinths where our reason very often goes astray: one concerns the great question of the Free and the Necessary, above all in the production and the origin of Evil; the other consists in the

discussion of continuity and of the indivisibles which appear to be the elements thereof, and where the consideration of the infinite must enter in” (edited with an introduction by Austin Farrer, translated by E. M. Huggard, Lasalle, Illinois, 1985 p. 53).

²²The problems are so well entrenched in seventeenth century thought that Locke does not feel obliged to explain what these inexplicable consequences are. See Boyle’s discussion of ‘*de compositione continuæ*’ in “A Discourse of Things above Reason, Enquiring Whether a Philosopher Should Admit There are Any Such” in *Selected Philosophical Papers* for one treatment.

²³ *The Will: A Dual Aspect Theory* (Cambridge, 1980), vol. 1, p. xxvi.

²⁴ The third source of ignorance is ‘want of tracing, and examining our *Ideas*’. The quoted passages are from a signpost that Locke offers at 4.3.23. See also the marginal summaries, and Stuart’s discussion in “Geometrical Analogy”, pp. 453-61.

²⁵ Translation by R. P. Hardie and R. K. Gaye in *The Complete Works of Aristotle: The Revised Oxford Translation*, edited by Jonathan Barnes, vol. 1 (Princeton, 1984). Jan Cover pointed me to the passage in Aristotle in the middle of a long and interesting e-mail on the topic.

²⁶ *New Essays Concerning Human Understanding*, edited and translated by Peter Remnant and Jonathan Bennett, Cambridge, 1981, p. 222. A reviewer pointed out to me that “liquid stuff has extension too” before I found the remark in the *New Essays*.

²⁷ *An Enquiry Concerning Human Understanding*, third edition, edited by L. A. Selby-Bigge and P. H. Nidditch (Oxford, 1975), p. 30.

²⁸ *Principles of Philosophy*, part 2, §§45-52. For a discussion of the collision rules, see Daniel Garber, *Descartes’ Metaphysical Physics*, (Chicago, 1992), chapters 7 and 8. Bill FitzPatrick helped me by criticizing my initial presentation of Locke’s point.

²⁹ *Principles of Philosophy*, part 2, §36.

³⁰ On light see Katherine Tachau, *Vision and Certitude in the Age of Ockham: Optics, Epistemology and the Foundations of Semantics 1250-1345* (Leiden, 1988), on the Eucharist, Stephen Menn, “The Greatest Stumbling Block: Descartes’ Denial of Real Qualities,” in *Descartes and his Contemporaries: Meditations, Objections, and Replies*, edited by Roger Ariew and Marjorie Grene (Chicago: 1995), on motion see Annaliese Maier, “The Nature of Motion,” in *On the Threshold of Exact Science*, edited and translated by Steven Sargent (Philadelphia, 1982). Leibniz writes that the Jes-

uit Father Casati thought of the transfer of motion as the transfer of a real accident “despite all the scholastics”, *New Essays*, pp. 171f.

³¹ *The Philosophical Writing of Descartes*, vol. 1, translated by John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge, 1985), p. 285. See also Boyle, “On the Origin of Forms and Qualities,” pp. 8, 15f, 21-23

³² *Ibid.*, vol. 3 translated by Cottingham, Stoothoff, Murdoch, and Anthony Kenny, p. 382

³³ *Philosophical Letters*, in *Women Philosophers of the Early Modern Period*, edited by Margaret Atherton (Indianapolis, 1994), pp. 24-28

³⁴ *New Essays*, p. 172. Remnant and Bennett suggest that such considerations may have pushed Leibniz towards the doctrine of pre-established harmony, *ibid.*, pp. lxiv-lxv, *s.v.* ‘Pre-established harmony’. For a very useful discussion see Eileen O’Neill, “*Influxus Physicus*,” in *Causation in Early Modern Philosophy: Cartesianism, Occasionalism, and Preestablished Harmony*, edited by Steven Nadler (University Park, Pennsylvania, 1993).

³⁵ In her previously cited paper with that subtitle

³⁶ “Mechanism, Superaddition, and God”, pp. 226f.

³⁷ *Isagoge*, paragraph 56. John Carriero first pointed me to this text, and Jeff Brower pressed a copy of *Five Texts on the Medieval Problem of Universals* into my hands.

³⁸ p. 43

³⁹ “Status of Mechanism,” p. 409.

⁴⁰ What this attribution amounts to is a matter of controversy, but on any good reading of those lines in 4.3.29, it will combine with the first few lines of that section to make a coherent skeptical argument.

⁴¹ On these points see R. S. Woolhouse’s *Locke’s Philosophy of Science and Knowledge* (Oxford, 1971), p. 140.

⁴² However, see also Stuart, “Superaddition and Mechanism”, pp. 376-79.

⁴³ She takes 2.8.22, 4.3.11, 4.3.16 to be passages “where Locke explicitly distances himself from the corpuscularian hypothesis” (“Mechanism in Locke,” p. 396). These are not passages where Locke abuses corpuscularianism. In 2.8.22, he calls it the subject somewhat outside his intended topic (though “necessary in our present Enquiry”) and in 4.3.16, he calls corpuscularianism a hypothesis. These passages do not go any way towards showing that Locke does not believe in corpuscularianism, since one may believe an off-topic hypothesis true and still believe it to be an off-topic hypothesis. In 4.3.11, Locke writes that secondary qualities “all [depend] (as has been shewn) upon the primary Qualities of their

minute and insensible parts; or if not upon them, upon something yet more remote from our Comprehension.” This is an avowal of corpuscularianism, along with a concession that he might be wrong.

⁴⁴ Ibid., p. 410

⁴⁵ For an elucidation of this inference, see my paper “Locke’s Resemblance Theses,” *The Philosophical Review* 108 (1999).

⁴⁶ The last sentence of “The Elements of Natural Philosophy,” *The Works of John Locke*, (London, 1823), vol. 3, p. 330 contains a vigorous endorsement of corpuscularianism, as McCann observes (“Lockean Mechanism,” p. 209). Stuart undermines the authority of that passage in “Superaddition and Mechanism,” pp. 378f.

⁴⁷ As I remarked in note 43, Locke hedges that he might be wrong.

⁴⁸ Compare Boyle on the ultimate natural inexplicability of motion (“A Proemial Essay, wherein, with some Considerations touching Experimental Essays in general, is interwoven such an Introduction to all those written by the Author, as is necessary to be perused for the better understanding of them”, in *The Works of the Honorable Robert Boyle*, London, 1772, vol. 1, p. 310) and Hilary Putnam on why a certain peg can fit in a certain hole (“Philosophy and our Mental Life” in his *Philosophical Papers*, Cambridge, 1975, vol. 2, pp. 295-98).

⁴⁹ I should concede that ‘contrary’ does not mean contradictory. Rather, in traditional usage, two propositions are called contraries when they cannot both be true but may both be false. (See, e.g., William and Martha Kneale, *The Development of Logic*, London, 1962, p. 56.) It is clear from context, however, that Locke believes that one of the two relevant contraries is true.

⁵⁰ *Works*, vol. 4, p. 467f.

⁵¹ He wrote to Richard Bentley that “gravity must be caused by an agent acting constantly according to certain laws, but whether this agent be material or immaterial is a question I have left to ye consideration of my readers” (February 25, 1693, *The Correspondence of Isaac Newton*, edited by H. W. Turnbull, J. F. Scott, A. R. Hall, and L. Tilling, Cambridge, 1959-77, vol. 3, pp. 253f.). As Richard Westfall observes, “he had not left it entirely to his readers, since Book II [of the *Principia*] had become a sustained argument against the existence of a material agent”

(*Never at Rest: A Biography of Isaac Newton*, Cambridge, 1980, p. 506).

⁵² For excellent remarks about Locke on gravity, see Stuart, “Superaddition and Mechanism,” pp. 355-59.

⁵³ *New Essays*, p. 61. According to Remnant and Bennett, the final quotation is from Ovid

⁵⁴ “Locke on Active Power and the Obscure Idea of Active Power From Bodies,” *Studies*

in the History and Philosophy of Science 11 (1980): 39-77, part I

⁵⁵ *Works*, vol. 9, p. 259

⁵⁶ Likewise, as Paul Humphries has suggested to me, if we feel a weight pressing upon us, we might feel the action of a body without perceiving any motion.

⁵⁷ A. Michotte, *The Perception of Causality*, translated by T.R. Miles and E. Miles (New York 1963), p. 20

⁵⁸ *Ibid.*, p. 103, see also pp. 218f.

⁵⁹ “Superaddition and Mechanism”, p. 377

⁶⁰ I am indebted to skeptical remarks from reviewers that showed me that a solution that I had proposed did not work.

⁶¹ I thank John Carriero, Rogers Albritton, Steven Nadler, and three anonymous reviewers for detailed criticism. A version of this paper was delivered as a talk at the University of Alabama. I thank the members of the audience, especially Torin Alter, who helped me rewrite the paper in the hours before I gave it. Other versions of the paper were delivered at Virginia Tech, Purdue, and Nebraska. I am grateful for the comments from those audiences as well. Section 1.2 is excerpted from some comments I gave on Edwin McCann's paper at the Annual Meeting of California Scholars in Early Modern Philosophy. I thank Ed for stimulus and response. In comments on another paper given at the same conference, Dan Sutherland made some insightful distinctions, including the distinction between perceiving that and perceiving how, and the distinction between thinking of a mechanical affection as an *explanans* and thinking of it as an *explanandum*. I was thinking along the same lines already, but Dan's remarks were useful catalysts. I thank Tad Brennan for a helpful discussion of the Aristotelian notion of property and for pointing me to the Port-Royal Logic. I thank Eric Verwillow for explaining the modern theory of cohesion to me.