6

Locks, Schlocks, and Poisoned Peas: Boyle on Actual and Dispositive Qualities

DAN KAUFMAN

A piece of gold dissolves when it is immersed in aqua regis: gold is dissolvable in aqua regis; *dissolvability in aqua regis* is one of the qualities of gold. Now, imagine a world with the same natural laws as the actual world. In that world, a piece of gold exists, but aqua regis does not. In that world, does gold actually have the quality *dissolvability in aqua regis*? According to Robert Boyle, the answer to this question is 'no'. In that world, is it true that *if* there were some aqua regis and a piece of gold were immersed in it, the gold would dissolve? According to Boyle, the answer is 'yes'. This seems like a strange thing to say, given Boyle's answer to the first question and his common-sense view that qualities (e.g. dissolvability) are not to be confused with their manifestations (e.g. dissolving). In this chapter, I hope to show why Boyle gives these answers. More importantly, I hope to show how Boyle can *consistently* give these answers.

It is safe to say that Boyle was obsessed with the topic of qualities. He wrote forty-two published works, and twenty-seven of them explicitly treat the qualities of bodies, both the mechanical production of qualities *in general* and the production of *particular* qualities.[1] Boyle's examination of qualities was, of course, not restricted to theoretical investigation, but included seemingly endless experiments to support the corpuscularian hypothesis and the theory of qualities Boyle understood it to entail. And given what Boyle says in the Preface to *The Origine of Formes and Qualities (According to the Corpuscular Philosophy)* (henceforth *OFQ*) about the importance of qualities, it is not surprising that he devoted so much energy to their investigation:

[1] Peter Anstey, *The Philosophy of Robert Boyle* [*Boyle*] (London: Routledge, 2000), 19.

> The Origine … and Nature of the Qualities of Bodies, is a Subject, that I have long lookt upon, as one of the most Important and Usefull that the Naturalist can pitch upon for his Contemplation. For the Knowledge we have of the Bodies without Us, being for the Most part, fetched from the Informations the Mind receives by the Senses, we scarce know anything else in Bodies, upon whose account they can worke upon our Senses, save their Qualities … And as 'tis by their Qualities, that Bodies act Immediately upon our Senses, so 'tis by vertue of those Attributes likewise, that they act upon Other bodies. (*Works*, v. 298)

Despite Boyle's obsession with qualities, he is surprisingly shy about giving a general definition of 'quality'. Rather, he thinks that it is sufficient, not to mention easier, to provide examples than to give a definition.[2] Among the properties Boyle claims are qualities are heat, cold, firmness, flexibility, brittleness, astringency, inflammability, volatility, fixity, colour, corrosiveness, poisonousness, magnetism, and electricity. His examples of qualities include certain 'manifest' qualities, 'chemical' qualities (a species of manifest), 'medical' qualities (species of manifest), sensible qualities, and occult qualities.[3] Boyle's reluctance to give a general definition of what qualities are, however, has led to interpretative difficulties. For instance, Peter Anstey and Edwin Curley—two scholars I believe to have done the most philosophically interesting work on Boyle[4]—have claimed that the likelihood of coming up with an interpretation of Boyle on qualities that is both internally consistent and accommodates all of the relevant texts is low, to say the very least. I wish to show that there is an interpretation that perhaps will not solve *every* interpretative problem associated with Boyle's theory of qualities, but it will go some way towards solving what I take to be one of the most problematic aspects of Boyle's theory, namely reconciling his

[2] See *Works*, v. 314–15 and vi. 267–8. Boyle does admit, however, that to give a general definition of "quality" 'be probably a much easier Task, then to define many Qualities, that may be nam'd in particular, as Saltness, Sowrness, Green, Bluw, and many others, which when we hear nam'd, every man know what is meant by them, though no man (that I know of) hath been able to give accurate Definitions of them' (*Works*, v. 315).

[3] See also *Works*, v. 360–1, and Anstey, *Boyle*.

[4] See Anstey, *Boyle*, ch. 4; Anstey, 'Robert Boyle and the Heuristic Value of Mechanism', *Studies in History and Philosophy of Science*, 33 (2002), 161–74, at 165; Edwin Curley, 'Locke, Boyle and the Distinction between Primary and Secondary Qualities' ['Distinction'], *Philosophical Review*, 81 (1972), 438–64.

''relative'' view of qualities (i.e. his view that qualities consist partly in actual relations between bodies and other things, either other bodies or perceivers) with his view that bodies can have ''dispositive qualities'' (i.e. bodies can have qualities dispositively, even in the absence of any actual relations that bodies may have to other things).

Before I get into the thick of things, I wish to mention something I will *not* do in this chapter: I will not talk about ''primary and secondary qualities'' in Boyle. More precisely, I will not use these terms. The influence of Locke on the study of Boyle has resulted in the phenomenon of 'Locke-ing' Boyle;[5] that is, recognizing Boyle's influence on Locke, and then reading Locke's views back onto Boyle. Scholars of Boyle recognize that, contrary to what most philosophers may think, he *never* in fact uses the term ''primary quality'' and only uses ''secondary quality'' twice. Moreover, in half of these cases (i.e. *one* case), Boyle uses the term ''secondary quality'' to refer to a medical quality, i.e. the purgative (i.e. laxative) quality of rhubarb.[6] However, perhaps because of familiarity or convenience, scholars proceed to use these terms when discussing Boyle. And, unlike Locke, Boyle explicitly refuses to call size, shape, texture, and motion ''qualities'' at all, let alone ''primary qualities''.[7] If we philosophers are going to take Boyle seriously in his own right, and not merely as a precursor and influence on Locke, then we need to be careful with his own technical vocabulary.

1. MECHANICAL AFFECTIONS AND QUALITIES

1.1. What Are qualities?

Although Boyle does not give an informative definition of what qualities are, he repeatedly tells us what qualities *do*. He states that the 'severall powers to act on other Bodies or dispositions to be wrought on by them; which (Attributes) do as well deserve the name

[5] This is, as far as I know, Laura Keating's term in Keating, 'Un-Locke-ing Boyle: Boyle on Primary and Secondary Qualities', *History of Philosophy Quarterly*, 10 (1993), 305–23.

[6] See Anstey, *Boyle*, 39, and Keating, 'Un-Locke-ing Boyle'. Boyle uses the term ''sensible quality'', however. See *Works*, ii. 98.

[7] For instance, in *Cosmical Qualities*, Boyle states: 'I consider that the Qualities of particular Bodies (for I speak not here of Magnitude, Shape, and Motion, which are the Primitive Moods and Catholick Affections of Matter itself) …' (*Works*, vi. 287).

of Qualities, as diverse other Attributes to which it is allow'd' (*Works*, vi. 268). Qualities are those features of bodies in virtue of which bodies cause both changes in other bodies and perceptions in perceivers, and are acted upon by other bodies. In so far as they are one of the relata of any causal relation,[8] they are explanatory, in accounts both of perception and of purely physical phenomena (see *Works*, v. 324). As such, the knowledge of qualities makes up 'the most fundamental and useful part of Natural Philosophy' (*Works*, v. 288). Not only are qualities explanatory (i.e. in the sense that they explain why some *past* phenomenon happened), they are also have predictive power; that is, knowledge of a body's qualities will allow the natural philosopher to predict future phenomena. Boyle thinks that a feature of an 'excellent hypothesis' is that it will 'enable a skillfull Naturalist to Foretell Future *Phænomena*'.[9] Boyle certainly considers the corpuscularian hypothesis to be excellent, and, as we'll see, he believes his theory of qualities to be entailed by the corpuscularian hypothesis. Presumably, the fact that knowledge of qualities aids knowledge of what a body will do in certain conditions is another reason why Boyle thinks that knowledge of qualities is crucial to natural philosophy.

One of the more difficult aspects of Boyle's view of qualities to make sense of is his view that qualities are *in* bodies (see e.g. *Works*, v. 298, vi. 283). As we'll soon see, Boyle thinks that for a body to have a quality it must stand in some actual relation to another body or perceiver, and as such qualities are not wholly intrinsic properties of an individual body.[10] However, this does not mean that the quality is not *in* that body. For example, a piece of gold has the quality of *dissolvability in aqua regis* only if there is some aqua regis; nevertheless, the dissolvability is a quality of the piece of gold not of the aqua regis, nor of the gold *plus* the aqua regis. Presumably, this is one of the reasons why Boyle writes separately about corrosiveness and

[8] For example, aqua regis dissolves gold because of a quality of the aqua regis and because of a quality of the gold. In this case, we might say that aqua regis has an active quality, and the gold has a passive quality.

[9] 'Notes on a Good and an Excellent Hypothesis' (untitled by Boyle), in *Selected Philosophical Papers of Robert Boyle*, ed. M. A. Stewart (Indianapolis: Hackett, 1991), 119.

[10] It is notoriously difficult to give an account of an intrinsic property. However, on both the "intuitive" account (an intrinsic property of x is a property that x could have even if were lonely) and David Lewis's account (an intrinsic property of x is one that would be shared by any duplicate of x), Boylean qualities are not intrinsic properties.

corrosibility and the aperitive and "aperitable" qualities. This is not that strange if we recognize Boyle's qualities as asymmetric relational properties. An asymmetric relational property of an individual x, such as *being taller than*, is had by x only if there is some y shorter than x; but this property is a property of x, not y.

1.2. A brief overview of boyle's corpuscularian ontology

An exhaustive examination of Boyle's ontology is far beyond the scope of this chapter. However, I wish to give a brief overview for the purposes of distinguishing qualities from 'mechanical affections'.

Boyle is careful to present his corpuscularianism in terms neutral with respect to the ultimate structure of matter; that is, he doesn't wish to formulate his theory in a way that would require that matter be atomistic, nor that it would require that matter be infinitely divisible (*Works*, viii. 103–4). Yet it is fairly clear that he accepts the existence of very small, *naturally* indivisible bodies.[11] These bodies have proper parts, but are indivisible by any natural means (or the likelihood of natural division is so negligible as to be almost non-existent), although they could be divided by God or by our minds (i.e. by a *distinctio rationis*).[12] Boyle sometimes refers to these naturally indivisible bodies as 'corpuscles', but when he is being precise, he calls them 'minima naturalia' to distinguish them from the teeny-weeny aggregates of *minima*, which Boyle also calls 'corpuscles'. These

[11] See Thomas Holden, *The Architecture of Matter from Galileo to Kant* (Oxford: Oxford University Press, 2004), ch. 1, for a helpful catalogue of the various types of divisibility discussed in the 17th century. On Holden's account of the types of divisibility, Boyle's *minima* are physically indivisible, metaphysically divisible, formally divisible, and intellectually divisible.

[12] 'That there are in the World great store of Particles of Matter, each of which is too small to be, whilst single, Sensible; and, being Entire, or Undivided, must needs both have its Determinate Shape, and be very Solid. Insomuch, that though it be *mentally*, and by Divine Omnipotence divisible, yet by reason of its Smalness and Solidity, Nature doth scarce ever actually divide it; and these may in this sense be call'd *Minima* or *Prima Naturalia*' (*Works*, v. 325–6). See also 'Of the Atomicall Philosophy', an early manuscript (1651–3), where Boyle claims that material "atoms" are not 'indivisible or Mathematicall points which are so void of quantity that the subtle rasor of Imagination it selfe cannot dissect them, but minima Naturalia or the smallest particles of bodyes, which [atomists] call Atomes not because they cannot be suppos'd to be divided into yet smaller parts … but because tho they may be further subdivided by the Imagination yet they cannot by Nature, which not being able in her resolutions of Naturall bodyes to procceed ad infinitum must necessarily stop somewhere' (*Works*, xiii. 227).

minima have only three properties:[13] size, shape, and motion or rest. Boyle tries to establish the properties of *minima* in at least three ways. First, there is Boyle's use of *transdictive inference*, a common form of inference among natural philosophers of the seventeenth and eighteenth centuries. Transdictive inference has roughly the following form (subject, of course, to specifying appropriate Fs): All observable or observed Fs have property *p*; therefore, unobservable Fs have *p*.[14] Boyle is employing transdictive inference when he states: 'And since Experience shews us … that this division of Matter is frequently made into insensible Corpuscles or Particles, we may conclude, that the minutest fragments, as well as the biggest Masses of the Universal Matter are likewise endowed each with its peculiar Bulk and Shape' (*Works*, v. 307).[15] Because all sensible bodies have a determinate size and shape (and implicitly, Boyle is assuming that division of a body results merely in more bodies), he infers that the smallest bodies or *minima* will have a determinate size and shape.

Second, in one of the only clear-cut cases of a priori, "metaphysical" reasoning,[16] Boyle argues for the properties of *minima* from the very

[13] See Antonio Clericuzio, *Elements, Principles, and Corpuscles: A Study of Atomism and Chemistry in the Seventeenth Century* [*Elements*] (Dordrecht: Kluwer, 2000), chs. 1 and 4. Clericuzio claims that there are reasons to think that Boyle—at least *sometimes*—holds that *minima* have properties other than just the mechanical affections, and Clericuzio takes this to indicate the influence of the alchemical–chymical tradition on Boyle. Obviously, these issues are too large and complex to address adequately in the present chapter. I will point out, however, that in *OFQ* (Boyle's most detailed theoretical discussion of qualities and mechanical affections) there is no clear evidence that he holds that *minima* have anything other than mechanical affections. In my view, the fact that Boyle thinks that *minima* have only mechanical affections indicates a break with the alchemical–chymical tradition in so far as that tradition held that *minima* are the smallest particles of elements. The additional properties of *minima* in that tradition are included in Boyle's category of "manifest qualities", and there is no indication that Boyle thinks that those qualities are had by *minima*. See *Works*, vi. 267–8. Thanks to Dan Garber for making me think more about this. Presently, I use 'property' in a neutral manner to refer to qualities, mechanical affections, and anything else we attribute to something. Later it will be used in a more technical sense, a sense that will be explicitly indicated.

[14] See Andrew Pyle, *Atomism and its Critics: Problem Areas Associated with the Development of Atomic Theory of Matter from Democritus to Newton* [*Atomism*] (Bristol: Thoemmes Press, 1995), 528–39.

[15] Other famous instances of transdictive inference are found in Descartes (in the French version of *Principles of Philosophy*, iv. 201) and Newton (his '3rd rule of Reasoning' in the *Principia*). See Robert Wilson, 'Locke's Primary Qualities', *Journal of the History of Philosophy*, 40 (2002), 201–28. A related notion is what Anstey calls "the familiarity condition", which states that we explain the unfamiliar in terms of the more familiar.

[16] Another is the case of the lonely corpuscle.

concept of *body*: 'For being a finite Body, its Dimensions must be terminated and measurable: and though it may change its Figure, yet for the same reason it must necessarily have *some Figure* or other' (*Works*, v. 307). The concept of *body* is such that, although an individual body can change with respect to its determinate shape, the determinable *shape* is essential to it—it simply wouldn't be a body otherwise. The same goes for the other mechanical affections, size and motion or rest.

Third, there is *the Case of the Lonely Corpuscle*.[17] In this thought experiment, Boyle considers which properties a single *minima* would have if it were 'lonely', i.e. if it were the only material thing in existence. Boyle thinks that a lonely corpuscle would have only the mechanical affections: size, shape, and motion or rest. As he states: 'if we should conceive that all the rest of the Universe were annihilated, except any of these entire and undivided Corpuscles … it is hard to say what could be attributed to it, besides Matter, Motion (or Rest), Bulk, and Shape' (*Works*, v. 315). And 'these three, namely *Bulk, Figure*, and either *Motion* or *Rest*, (there being no Mean between these two) are the three *Primary* and most *Catholick Moods* or Affections of the *insensible* parts of Matter, consider'd *each* of them *apart* (*Works*, v. 333; my emphasis).[18] As we will see, a lonely corpuscle would have no *qualities* at all.

Boyle, however, thinks that aggregates of *minima* have an additional and extremely important mechanical affection: texture. Texture is the structure or arrangement ('disposition', as Boyle sometimes calls it) of aggregates of *minima*. Given the work that textures do in Boyle's corpuscularianism, however, texture cannot be merely the arrangement of *minima*, if arrangement is only the *spatial* arrangement of *minima*, i.e. the spatial relations among the *minima* in the aggregate. Rather texture also includes the mechanical affections of the individual *minima* composing the aggregate; and in the case of a larger body, its

[17] As far as I know, 'lonely corpuscle' is Peter Alexander's term in Alexander, *Ideas, Qualities and Corpuscles: Locke and Boyle on the External World* [*Ideas*] (Cambridge: Cambridge University Press, 1985). See also Pyle, *Atomism*, 539–44.

[18] See also *Works*, v. 334. In *Ideas*, Alexander thinks that texture is not a mechanical affection for Boyle (although Alexander uses the term ''primary quality''), nor is it a primary quality for Locke. The reason: texture is not a feature of a lonely corpuscle. This shows, according to Alexander, that texture is not *inseparable* from all bodies and hence fails one of the tests for being a Lockean primary quality or Boylean mechanical affection. See Wilson, 'Locke's Primary Qualities', and Anstey, *Boyle*, for reason to think that texture is a primary quality for Locke and a mechanical affection for Boyle.

texture will include the textures of the smaller aggregates of *minima* composing the larger body. For Boyle, the shape (for instance) of the *minima* that compose the aggregate is going to be relevant to the qualities that the body's texture will produce (see e.g. *Works*, VI. 529). As such, we need to include the mechanical affections of the *minima* in the arrangement as a feature of the texture of a body.

Boyle calls size, shape, motion or rest, and texture the *mechanical affections*, and they are the only wholly intrinsic properties of any composite body; and, as I have mentioned, all but texture will be properties of all bodies, whether a single *minima* or an aggregate of *minima*.

From even a superficial reading of Boyle, we can see that there is a very important relationship between the mechanical affections of a body and its qualities. Boyle says that qualities are 'derived from', 'can be deduced from', and 'depend on' the mechanical affections. A case could be made—and has been made by Peter Alexander among others—that qualities are numerically identical to textures or other mechanical affections. It has been rightly pointed out by several scholars (e.g. Anstey, Curley, Keating, and O'Toole), however, that things are not that simple. In fact, there are overwhelming reasons to think that identifying qualities with the mechanical affections of a body is greatly mistaken. In Boyle's most explicit pronouncements about qualities, he absolutely denies this view. There are texts, however, in which Boyle appears to say that qualities are identical to mechanical affections. I will say something towards the end of the chapter about these texts.

2. BOYLE'S 'EXCURSION' AND RELATIVE QUALITIES

The problem on which I will focus concerns the tension arising from Boyle's relative theory of qualities *and* his acceptance of so-called dispositive qualities. In order to see how this tension arises, we first must look at Boyle's theory of qualities, presented most fully in '*An* EXCURSION *about the* Relative Nature *of* Physical Qualities' in *OFQ* (henceforth, the 'Excursion'). In the 'Excursion', Boyle presents several examples to show that two things are true. First, scholastic philosophers who believe in *qualitates reales* are greatly mistaken about the nature of qualities. Boyle thinks, contra those philosophers, that

the attribution of a multiplicity of qualities to a body does not require attributing a multiplicity of distinct real entities to a body. In fact, Boyle calls the scholastic view 'the Grand Mistake' (*Works*, v. 309). For the sake of this discussion—which will not suppose that Boyle has gotten the subtleties of the scholastic position right—the scholastic view is simply the view that for every quality we attribute to a body, there is some distinct (i.e. separable) entity in that body.[19] So, the more attributes a body has, the more real entities there are in that body,[20] and if a body gains a new quality, something intrinsic to the body must be added. Second, the corpuscularian account of qualities is true and perfectly adequate to explain the origin, nature, and multiplicity of qualities. I must point out that the first goal (the attack on the Grand Mistake) depends almost wholly on the success on the second goal. That is, Boyle's examples show the scholastics' Grand Mistake only if the positive corpuscularian account of qualities is successful. Boyle explicitly states that '*unless we admit the Doctrine I have been Proposing* [i.e. the corpuscularian view of qualities as Boyle has just presented it], we must Admit, that a Body may have an almost Infinite Number of New Real Entities accruing to it, without the Intervention of any Physical Change in the Body its self' (*Works*, v. 311; my emphasis). The implication is clear: if Boyle's theory of qualities is false, then his attack on scholastic real qualities fails. I mention this now because a problem will arise from this later.

The most famous example in the 'Excursion' used for these two purposes is the example of the lock and key. Though this passage is well known, I quote it at length:

> We may consider, then, that when *Tubal-Cain*, or whoever else were the Smith, that Invented *Locks* and *Keys*, had made his first Lock, (for we may Reasonably suppose him to have made that before the *Key*, though the Comparison may be made use of without that Supposition,) That was onely a Piece of Iron contriv'd into such a Shape; and when afterwards he made a Key to that Lock, That also in itself Consider'd, was nothing but a Piece of Iron of such a Determinate Figure: but in Regard that these two Pieces of Iron might now be Applied to one another after a Certain manner, and

[19] See Pyle, *Atomism*, 508–28.

[20] Boyle thinks that his theory avoids, and his scholastic opponents face, an issue of qualities "overcrowding" in a body (*Works*, v. 311).

that there was a Congruitie betwixt the Wards of the Lock and those of the Key, the Lock and the Key did each of them now Obtain a new Capacity and it became a Main part of the Notion and Description of a Lock, that it was capable of being made to Lock or Unlock by that other Piece of Iron we call a Key, and it was Lookd upon as a Peculiar Faculty and Power in the Key, that it was Fitted to Open and Shut the Lock, and yet by these new Attributes there was not added any Real or Physical Entity, either to the Lock, or to the Key, each of them remaining indeed nothing, but the same Piece of Iron, just so Shap'd as it was before. (*Works*, v. 309–10)

Before we examine this passage and what it tells us about qualities, we should notice that the 'clear implication is that the point made about the lock and key is illustrative of other qualities.'[21] In fact, the very title of the 'Excursion' concerns 'the Relative Nature of *Physical* Qualities'.[22] The example of the lock and key is intended to support a *general* corpuscularian theory of the qualities of bodies.

In order to get clear about what is going on in the example, let us spell it out in detail. Call the 'Piece of Iron contriv'd into such a Shape', existing before there is a key, a 'schlock'. Call the time at which there was a schlock but no key, t_1, and the time at which there was a schlock and a key, t_2. There are several points to recognize in this passage:

(1) At t_1, the only (relevant)[23] features of the schlock are its mechanical affections.
(2) At t_1, the schlock does not have an aperitable[24] quality (i.e. the openable quality).
(3) At t_2, the schlock acquires the aperitable quality.
(4) Absolutely nothing intrinsic about the schlock changes from t_1 to t_2. It retains all and only the same determinate mechanical affections.
(5) It is in virtue of its mechanical affections *plus* its *actual relation* to the newly existing key that the schlock acquires a new ability,

[21] Anstey, *Boyle*. 87.

[22] Note that Boyle states that *physical* qualities have a relative nature. He is therefore not limiting his account to strictly "sensible" qualities. *All* qualities of bodies have a relative nature.

[23] The schlock has *some* qualities (e.g. colour), but it lacks the quality under discussion.

[24] I think I have invented this word. In *A Free Enquiry*, Boyle refers to the ability of a key to open a lock as an "aperitive" quality. A body has an aperitable quality when there is a body with a corresponding aperitive quality. See *Works*, x. 561.

> a new quality. This is precisely the thrust of the attack on scholastic *qualitates reales*: there is no new *real* quality, despite the fact that there *is* a *new* quality in the lock.[25]

In *Men's Great Ignorance*, Boyle again presents the lock and the key example for the same positive purpose (minus an explicit attack on *qualitates reales*):

> I consider in the second place, That the Faculties and Qualities of Things being (for the most part) but certain Relations, either to one another (as between a Lock and a Key;) or to Men, as the Qualities of External things referr'd to our Bodies, (and especially the Organs of Sense,) when other Things, whereto These may be related, are better known, many of These with which we are now more acquainted, may appear to have useful Qualities not yet taken notice of … To our present purpose it may suffice to adumbrate my Meaning by the newly hinted Example of a Lock and a Key, where, *as* that which we consider in a Key, as the power or facultie of Opening or Shutting supposes and depends upon the Lock whereto it corresponds; *so* most of those Powers & other Attributes that we call Qualities in Bodies, depend so much upon the Structure or Constitution of other Bodies that are dispos'd or indispos'd to be acted on by them … (*Works*, vi. 521–2)

This passage and the 'Excursion' make it clear that Boyle thinks that the qualities of a body are not fully reducible to (a fortiori, not identical to) any intrinsic property or mechanical affection of that body. If they were, then it would be impossible for a body to acquire new qualities without some change of mechanical affection.[26] But Boyle's examples explicitly deny this suggestion.[27] This should come as no surprise. Whereas mechanical affections are wholly intrinsic feature of bodies, qualities are not.[28]

The relative theory of qualities is reiterated throughout Boyle's works. For instance, in 'An Introduction to the History of Particular

[25] See *Works*, vi. 287, and the discussion of corrosiveness and corrosibility in viii. 337, 472–3.

[26] See Curley, 'Distinction', and Reginald Jackson, 'Locke's Distinction between Primary and Secondary Qualities', *Mind*, 38 (1929), 56–76.

[27] Boyle does believe that bodies *can* change qualities in virtue of a change in their mechanical affections. He does not, however, think that a change in mechanical affections is either necessary or sufficient for a change of qualities. See, for instance, *Works*, iv. 26.

[28] See Clericuzio, *Elements*, 137.

Qualities', in the example of the distilled putrefied urine[29] (*Works*, vi. 282–3): 'the same body … may, by vertue of its Shape and other mechanicall Affections … have such differing respects to different Sensories, and to the Pores, &c., of divers other Bodies, as to display severall differing Qualities' (*Works*, vi. 282). According to Boyle, distilled putrefied urine has all of the following relative qualities: pungent taste, offensive smell, white colour, causticity, lachrymatory quality, sneeze-producing quality, sedative-to-hysterical-women quality, diaphoreticity, diureticalness, a quality that causes brass filings to turn blue, a quality that causes some plant juices to turn green, and a quality enabling it to dissolve copper. At the end of this list, Boyle repeats: 'the same Particles applyd to severall other Bodies, to which they have differing Relations, have such distinct operations on them as may intitle these saline spirits to other Qualities. But to enumerate them in this place were tedious, especially haveing already nam'd so many Qualities residing in this spirituous Salt' (p. 283). This, Boyle says, illustrates the relative nature of qualities, that 'this or that Relation to other Bodies, divers of which Relations we stile Qualities' (p. 280).

Boyle does not, however, think that different relations automatically entail a diversity of qualities.[30] Boyle mentions 'how great the power may be, which a Body may exercise by virtue of a single Quality, may appear by the Various and oftentimes Prodigious Effects, which Fire produces by its Heat, when thereby it melts Mettals, calcines Stones, destroyes whole Woods and Cities, &c.' (*Works*, v. 324–5). Prima facie this passage seems to be in stark contrast to the putrefied urine example. In the latter, Boyle seems to think that each of the various relations establishes a distinct quality in the urine, but in the former, Boyle thinks that the quality which enables fire to produce various effects is but a single quality, namely heat. I don't think the views expressed here are incompatible. It is clear to me as it is to Boyle that the particular effects of fire listed by Boyle (i.e. melting, calcining, destroying wood) *are* the effects of its heat. However, fire's

[29] 'Spirit of urine', a solution of ammonia and ammonium carbonate (Hunter and Davis's Glossary in Boyle's *Works*).

[30] Boyle's strange example of the "father" in *OFQ* (*Works*, v. 309) illustrates this. Of course, when a man has a child, he becomes a father in virtue of this new relation; however, having more than one child, while producing another relation, does not endow the man with another "quality".

ability to cause the sensation of colour in me is due not to its heat but rather to its colour. The qualities of the urine listed by Boyle and their effects seem to be very unlike the effects of a fire's heat. Of course, if Boyle's corpuscularian natural philosophy is to be as 'excellent' as he thinks, there will need to be some way of distinguishing when a single quality is responsible for different effects and when a plurality of qualities is responsible. The fact that in many cases Boyle refrains from naming the quality but instead simply cites its effect(s) indicates that perhaps we do not have names for such qualities. In any case, it seems absolutely right for Boyle to say that the power that urine has to calm down hysterical women is a different quality from its pungent taste. In the case of the fire, it seems absolutely right for Boyle to say that each of the effects listed result from the same quality (heat).[31]

Finally, the necessity of actual relations for a body to have qualities is illustrated by a thought experiment repeated in several of Boyle's works. For instance, in *Cosmical Qualities*—a work that Boyle characterizes as a sequel to *OFQ*[32]—Boyle says:

> So that although if divers Bodies that I could name were placed together *in vacuo*, or removed together into some of those imaginary spaces, which divers of the Schoolmen fancie to be beyond the Bounds of our Universe, they would retaine *many* of the Qualities they are now endowed with; yet they would not have them All: but by being restored to their former place in this World, would regain a new *Set* of Faculties (or Powers) and Dispositions. (*Works*, vi. 287–8)[33]

If qualities were intrinsic properties of bodies, this thought experiment would fall flat on its face: A body in an *in vacuo* world or an 'imaginary space'[34] surely would have the same intrinsic properties as it has in

[31] This is supported by Boyle's words in *Works*, v. 313, where he says that diverse effects do not necessarily come from a diversity of qualities. Not surprisingly, the example used to illustrate this is *heat*! The sun can harden, soften, melt, thaw, vaporize, blanch, yellow, ripen, etc. But 'these are not distinct Powers or Faculties in the Sun, but onely the Productions of its Heat … diversify'd by the differing Textures of the Body that it chances to work upon'.

[32] See *Works*, vi. 288, and John Henry, 'Boyle and Cosmical Qualities', in Michael Hunter (ed.), *Robert Boyle Reconsidered* (Cambridge: Cambridge University Press, 1994), 119–38.

[33] This thought experiment is also found in *Works*, v. 318 and vi. 272, 275.

[34] "Imaginary space" was a technical term used by philosophers, largely in reaction to the Condemnation of 1277 in Paris, in which the denial of a vacuum was condemned, to refer to a possible empty space "beyond the world". See Daniel Garber, *Descartes'*

our world. The fact that Boyle discusses this thought experiment in several works should indicate the importance of the existence of other bodies and relations between them, and that he believes that qualities are not intrinsic properties.

3. THE ACTUAL–RELATION REQUIREMENT

We have seen so far that Boyle holds what I call the "Actual-Relation Requirement" (ARR) concerning qualities. Stated briefly, ARR is the view that a body has qualities only if it stands in an actual relation to another existent body or perceiver. Of course, most scholars recognize that Boyle holds ARR. As Peter Anstey says, 'In the *Forms and Qualities* and elsewhere Boyle speaks of the necessity of the existence of other bodies for the presence of a power. That is, both relata must be present and standing in some kind of relation for there to be a power in the agent.'[35] It isn't clear, however, what exactly it is for the relata to be *present*, nor in what kind of relation agent and patient must stand. Unfortunately, Boyle does not explicitly address these issues. Fortunately, throughout his works, he leaves hints as to how ARR is to be spelled out in more detail.

There are passages in which Boyle characterizes ARR in a 'loose' way, and there are passages in which ARR is characterized 'strictly'—though he does not characterize qualities both strictly and loosely concerning the same features of ARR.

3.1. Looseness of ARR

In 'Of Man's Great Ignorance of the Knowledge of Natural Things', Boyle says the following, first emphasizing ARR, and then indicating the looseness of this requirement:

Metaphysical Physics (Chicago: University of Chicago Press, 1992), 127; Edward Grant, *Much Ado about Nothing: Theories of Space and Vacuum from the Middle Ages to the Scientific Revolution* (Cambridge: Cambridge University Press, 1981); Edith Dudley Sylla, 'Creation and Nature', in A. S. McGrade (ed.), *Cambridge Companion to Medieval Philosophy* (Cambridge: Cambridge University Press, 2003), 184–7; Dennis Des Chene, *Physiologia: Natural Philosophy in Late Aristotelian and Cartesian Thought* (Ithaca, NY: Cornell University Press, 1996), 385–90; Pyle, *Atomism*, 232–43.

[35] Anstey, *Boyle*, 102.

As if there were no Lock in the World, a Key would be but a piece of Iron of such a determinate Size and Shape … For *as* if some barbarous *American* should among other pieces of Shipwrack, thrown by the Sea upon the Shore, light upon a Key of a Cabinet, he would probably look on it as a piece of Iron, fit onely for the inconsiderable Uses of any other piece of Iron made much broader at each end than in the middle; but, having never seen a Lock, would never dream that this piece of Iron had a faculty to secure or give access to all that is contain'd in some well furnisht Chest or rich Cabinet. (*Works*, vi. 522)

Although Boyle does not indicate much about the spatial distance between the key and the lock, let us suppose (something that is supported by and/or consistent with many other texts) that the cabinet with its lock are not to be found in the shipwrecked items; for all we know the lock could be hundreds of miles away. Nevertheless Boyle thinks that the barbarous American would be ignorant of the *fact* that the piece of metal (i.e. the key) has a certain quality. ARR, then, is pretty loose: whereas the lock and key both need to exist, they need not be in the same room or on the same beach together. Boyle also discusses quality-constituting relations between a body and 'an Innumerable company of other Bodies, whereof some are near it and others very remote' (*Works*, vi. 275). Spatial proximity then does not appear relevant when it comes to the relations that constitute qualities.[36] In fact, he seems to think that the mere existence of a new menstruum would endow gold with a new quality:

And if one should Invent another Menstruum (as possibly I may Think my self Master of such a one), that will but in part dissolve pure Gold, and change some part of it into another Metalline Body, there will then arise another new Property, whereby to distinguish That from other Mettals; and yet the Nature of Gold is not a whit other now, then it was before this last Menstruum was first made. (*Works*, v. 311)

The looseness of ARR is also indicated by the fact that Boyle thinks that the existence of an 'accidental' agent or patient (e.g. an accidental key, i.e. a piece of metal not specifically made for the lock but which

[36] I am merely pointing out that spatial proximity and 'current engagement' (i.e. when the key is actually in use, opening the lock) are irrelevant to ARR. However, as I will point out shortly, Boyle does not think that the existence of just-any-key is relevant to ARR: the aperitable quality of the lock depends on the existence of a particular key—one that would in fact unlock the lock. Thanks to Steve Nadler for bringing the need to clarify this to my attention.

nevertheless would open it) is enough to endow the relevant bodies with a particular quality. As Boyle states:

> Nature her self doth, sometimes otherwise, and sometimes by Chance, produce so many things, that have new Relations unto others: And Art, especially assisted by Chymistry, may, by variously dissipating Natural Bodies, or Compounding either them, or their Constituent Parts with one another, make such an Innumerable Company of new Productions, that will each of Them have new operations, either immediately upon our Sensories, or upon other Bodies whose Changes we are able to perceive, that no man can know, but that the most Familiar Bodies may have Multitudes of Qualities, that he dreams not of. (*Works*, v. 311; see also vi. 521, viii. 545)

Boyle thinks that the mere existence of something, whether spatially close to a body or not, which would act on or be acted upon by that body in certain ways, endows that body with a quality. Even if all the gold were located in Sydney and all the aqua regis were located in Denver, gold would still be dissolvable in aqua regis. For Boyle, actual qualities are clearly not to be confused with their manifestations; as long as the relevant relata exist, the relevant quality exists, no matter if it is never manifested. Boyle's qualities are superabundant and come cheap.

Boyle also thinks that there may be all sorts of 'unheeded' relations that we don't know about, but which result in qualities of which we are ignorant (see also *Works*, iii. 229, 262; vi. 287–9). In the 'Excursion', he states that his view, unlike the scholastic view of qualities, can accommodate 'an almost Infinite Number' of qualities. Given that a body may stand in a huge number of quality-endowing relations to other bodies or to perceivers, and that there is a huge number of 'unheeded' relations, a body may have a correspondingly huge number of qualities arising from these relations. As Boyle says, there may be a 'much vaster multitude of *Phænomena*, and among them of Qualities, then one that does not consider the matter attentively would imagine' (*Works*, vi. 275; see also v. 311, quoted above). This passage, and others like it, indicate something very important, namely that Boyle thinks that whether a body actually has a quality is not an epistemic matter of whether someone knows that a body has a quality or whether a quality has been manifested (see also *Works*, viii. 545). Gold would still be dissolvable in aqua regis even if no one ever knew

about this quality of gold; but gold would not have this quality if there were no aqua regis in the world.

3.2. Strictness of ARR

We have seen so far that ARR is fairly loose in what it requires for there to be a quality-endowing relation. However, in other respects, Boyle characterizes ARR more strictly. For instance, he thinks that the aperitable quality of the lock not only requires the existence of a key but a key that would in fact lock or unlock that lock if it were 'duly apply'd' to it; that is, every *actual* quality depends on a particular agent or patient. The example of the poisoned peas in the 'Excursion' illustrates this point. In this example, Boyle relates a story of three nuns who were poisoned when ground glass was mixed with their peas. Boyle thinks that the 'Deleterious Faculty' or poisonous quality of the peas is present in them only in relation to the three nuns who were poisoned by the peas; the peas did not have a poisonous quality in relation to 'diverse others of the Sisters (who yet escap'd unharm'd)' (*Works*, v. 311). Do we then want to say that the peas were poisonous *simpliciter*, yet the nuns other than the three were not poisoned by them? I don't think Boyle is saying that. Qualities are those properties that, among other things, tell us what a body would do in certain circumstances (i.e. the manifestation conditions). To say that the peas are poisonous is to say that there is a relevant patient, and if she ate the peas, she would be poisoned. But, as Boyle says: 'though the three Nuns we have been speaking of were Poison'd by the Glass, yet many others who eat of the other Portions of the same mingled Pease, receiv'd no mischief thereby' (*Works*, v. 312). Just as the qualities of a particular lock depend on the existence of a particular key (and not just *any* key), likewise, the existence of the poisonous quality of the peas depends on having particular patients (e.g. the three nuns), such that *those* patients would be poisoned by the peas if they were to eat the peas. In the same vein, Boyle says that certain animals whose stomachs are 'Lin'd or Stuff'd with Gross and Slimy Matter', would be able to eat the peas without being harmed.[37]

[37] *Works*, v. 312, and Jennifer McKitrick, 'A Case for Extrinsic Dispositions' ['Extrinsic Dispositions'], *Australasian Journal of Philosophy*, 81 (2003), 155–74.

In other words, the peas are not poisonous to those animals; so, if the peas were in a world in which the only animals were the animals with slimy stomachs, the peas would not have a poisonous quality at all. We have already seen something like this, when Boyle characterizes gold not as dissolvable *simpliciter*, but as dissolvable *in aqua regis*. In fact, in the following passages Boyle seems to gloss *Q is a relative quality* precisely as *Q is a quality only relative to a particular x*:[38]

> This *Corrosibility* of Bodies, is as well as their Corrosiveness a Relative thing; as we see, that Gold, for instance, will not be dissolved by *Aqua fortis*, but will by *Aqua Regis*; whereas Silver is not soluble by the latter of these Menstruums, but is by the former. … the Quality, that disposes the body if affects to be dissolv'd by Corrosive and other Menstruums, does (as hath been declared) in many cases depend upon the Mechanical Texture and Affections of the body *in reference to the Menstruum that is to work upon it* … (*Works*, viii. 472–3; see also iii. 344)

> [Qualities are those things] upon whose account one Body is fitted to act upon others, or disposed to be acted on by them, and receive Impressions from them; as Quicksilver has a Quality or Power … to dissolve Gold and Silver, and a Capacity or Disposition to be dissolved by *Aqua fortis*, and (though lesse readily) by *Aqua Regis*. (*Works*, viii. 287)

And in *A Free Enquiry into the Vulgarly Receiv'd Notion of Nature*, he says:

> And so a Key may either acquire or lose its Power of opening a Door (which, perhaps, some School-Men would call its *aperitive Faculty*,) by a Change, not made in itself, but in the Locks it is apply'd to, or in the Motion of the Hand, that manages It. (*Works*, x. 561–2)

Beyond the point about a particular agent or patient, there are two important further points being made about ARR in the passage from *A Free Enquiry*: (1) By changing the locks that a key previously fitted, the key, despite no change in its mechanical affections, may lose a quality.[39] Therefore, qualities are not identical to mechanical

[38] It is acceptable to say that a body B_1 has Q in virtue of the existence of bodies of kind K, where each of the K-bodies are individuals whose existence (without other members of K) would be sufficient to endow B_1 with Q. Also, for Boyle, kinds are dependent (at least for their initial formation) on individuals.

[39] Sydney Shoemaker calls dispositional properties that can be lost or gained merely by altering other bodies 'mere-Cambridge powers' and claims that Boyle's qualities are examples of these: 'A particular key on my key chain has the power of opening locks of a certain design. It also has the power of opening my front door. It could lose the former

affections, nor are they wholly intrinsic properties of bodies. (2) The inability to apply the key to the lock eliminates the aperitive quality of the key. Many contemporary philosophers, myself included, think that it makes sense to say that a body has a disposition, even if it is not going to be manifested. Boyle, however, in the passage above, presents a case in which a key is appropriately shaped, a suitable lock exists, the laws of nature are constant (I'm supposing), and yet the key may lose its aperitive quality in virtue of 'the Motion of the Hand, that manages It.' This is a very strange thing to say. Does Boyle really mean that, say, an awkward person who mismanages the key—the way Ted Striker from the classic motion picture *Airplane* has a "drinking problem": he can hold the drink, but when he attempts to drink it, he misses his mouth—causes that key to lose its aperitive quality? Does the key lose its aperitive quality only when in the possession of that person?

Unfortunately, Boyle does not go into detail here. Frankly, the only way for me to make sense of Boyle's suggestion is to consider something like a world in which *everyone* is stricken with a shaking palsy; everyone in that world shakes so much that, just as a matter of fact, no one ever manages (or will ever manage) to insert the key into the lock and turn it. In the shaking world the manifestation conditions for the aperitive quality are metaphysically and nomologically possible, but are never actually going to obtain. The case of the shaking world is a case in which two worlds (say, our world and the shaking world) are indistinguishable with respect to the two-place relation between the key and the lock (or the *n*-place relation between the key, the lock, the laws of nature, 'unheeded agents', etc.), but the key doesn't have the aperitive quality in the shaking world. This seems to indicate that the likelihood of manifestation is relevant to the existence of a quality *within a world*; while I claimed earlier that the mere existence of the relevant relata is sufficient for the existence of a quality, it now

power only by undergoing what we would regard as a real change, for example, a change in its shape. But it could lose the latter without undergoing such a change; it could do so in virtue of the lock on my door being replaced by one of a different design. Let us say that the former is an intrinsic power and the latter is a mere-Cambridge power' (Sydney Shoemaker, 'Causality and Properties', in Shoemaker, *Identity, Cause, and Mind* (Cambridge: Cambridge University Press, 1984), 221). See also McKitrick, 'Extrinsic Dispositions', and Curley, 'Distinction'.

appears that Boyle is claiming the contrary. We can make some sense of this, though unfortunately not perfect sense, if we acknowledge that, for Boyle, *quality-endowing relations are never two-place relations*.[40] The laws of nature and 'unheeded agents' are going to be a relatum of any quality-constituting relation, even in relatively straightforward cases. For instance, in *A Free Enquiry*, Boyle says:

> For an Individual Body, being but a Part of the World, and incompass'd with other Parts of the same great *Automaton*, needs the Assistance, or Concourse, of other Bodies, (which are external Agents) to perform divers of its operations, and exhibit several *Phænomena's*, that belong to it … For, whatever the Structures of these living Engines [i.e. animals and plants] be, they would as little, without the Co-operations of external Agents; such as the *Sun, Æther, Air, &c.* be able to exercise their Functions … (*Works*, x. 469)

Following this passage Boyle also includes 'the *laws of motion* freely established and still maintained by God' as a relatum in any quality-constituting relation. In other places, he explicitly contrasts the treatment of qualities found in *OFQ* (in which he emphasizes the relative nature of qualities illustrated by *noticeable* relations) with the emphasis found in *Cosmical Qualities*:

> I have in the *Origine or Formes* touched upon this subject already, but otherwise than I am now about to doe. For whereas that which I doe *there* principally, (and yet but Transiently) take notice of, is *That one Body being surrounded with other Bodies, is manifestly wrought on by many of those among whome 'tis placed:* that which I chiefly in *This Discourse* consider is, the Impressions that a Body may receive, or the power it may acquire, from those vulgarly unknown, or at least vnheeded Agents, by which it is thus affected, not only upon the account of its owne peculiar Texture or Disposition, but by vertue of the generall Fabrick of the World. (*Works*, vi. 288)

[40] In the shaking world, one of the relevant relata is a person capable of inserting the key into the lock. So, this shaking world is simply a bizarre instance of the absence of one of the relata required for the presence of a quality. However, I don't think that this suggestion completely helps this case. Even if everyone has the shaking palsy, it is both metaphysically and nomologically possible that a shaking key-holder simply gets lucky and manages to insert the key and open the lock. Or that a wind blows the key into the lock and it is opened. These possibilities are especially troubling when we consider the abundance of ''accidental'' or ''lucky'' congruities in nature. I honestly do not know what to say about these cases.

And in *OFQ*, Boyle explicitly mentions that the quality of whiteness is present in crushed ice 'by reason of the Fabrick of the World, and of our Eyes' (*Works*, v. 320). In a world with different laws, crushed ice may cause the sensation of redness; in a world with different laws, a force field may be generated when the key is brought closer to the lock, which prevents insertion; etc.

Finally, ARR requires that the bodies in question (as well as the other relevant relata) are contemporaries, i.e. a body has a quality at t only if all of the relata required for that quality exist at t. Whereas spatial proximity seems to be irrelevant to ARR, contemporaneousness is required by ARR. This is illustrated, once again, by Boyle's example of the lock and key and the example of the gold and the newly invented menstruum: it is only when the key comes into existence that the lock acquires its aperitable quality, and once the menstruum is invented, the gold acquires a new quality. Conversely, the lock and key can lose the quality through a subsequent change in the other.

We have now spelled out in more detail the requirements of Boyle's ARR for the existence of a quality. It is apparent just how far his thinking about qualities diverges from contemporary views of qualities as dispositions or powers. In contemporary discussions of dispositions and powers, two ideas have widespread acceptance: That dispositions are reducible to their bases (i.e. the categorical properties which endow the body with dispositions),[41] and that intrinsic duplicates will share all and only the same dispositions.[42] For the sake of discussing Boyle, let us characterize intrinsic duplicates as individuals having qualitatively identical mechanical affections.[43] Boyle, as we have seen, disagrees with both of these widespread views: he thinks that qualities are not reducible to their bases, in his case, the mechanical affections; and he thinks that *it is possible that intrinsic duplicates differ in their qualities at different times in the same world* and *it is possible that intrinsic duplicates*

[41] A notable exception is McKitrick, who argues that at least some dispositions are not intrinsic properties ('Extrinsic Dispositions').

[42] For instance, Mark Johnston, 'How to Speak of the Colors', *Philosophical Studies*, 68 (1992), 221–63; David Lewis, 'Finkish Dispositions', *Philosophical Quarterly*, 47 (1997), 143–58; George Molnar, *Powers: A Study in Metaphysics* (Oxford: Oxford University Press, 2003).

[43] By characterizing intrinsic duplicates in this way, if $x = y$, then x and y (at the same time) are intrinsic duplicates.

differ in their qualities at the same time in different worlds.[44] The former can happen in several ways, perhaps because the body required for the existence of a quality begins or ceases to exist, or because an 'unheeded' relation required for the existence of a quality begins or ceases to obtain, or because the laws of nature change. The schlock–lock–key case explicitly illustrates that intrinsic duplicates can have different qualities in the same world at different times. Moreover, Boyle thinks that the natural laws are what I call 'ultra-contingent', obtaining only because God's wills them to obtain, and to have the content they do only because God's wills them to. I say that they are 'ultra-contingent' because unlike many other philosophers who believe that the natural laws are contingent in so far as they are willed by God, Boyle parts company with these philosophers and holds a more radical position: whereas many philosophers hold that God creates the natural laws, once he has done so, he is 'bound' to uphold them, Boyle believes that God creates the laws and can also *change* them: 'the most free and powerful Author of those Laws of Nature, according to which all the *Phenomena* of Qualities are regulated, may (as he thinks fit) introduce, establish or change them in any assign'd portion of Matter' (*Works*, viii. 312). And: 'laws of nature determin'd and bound up other Beings to act accordingly to them, yet he has not bound up his own hands by them, but can envigorate, suspend, over-rule; and reverse any of them as he thinks fit.'[45] So, intrinsic duplicates in different worlds could stand in the appropriate relation (i.e., say, the relation that the lock and key stand in with respect to each other, the relation that endows each with the relevant qualities) and yet lack those qualities owing to different natural laws. And because Boyle thinks that God not only created the natural laws but also could change them now, intrinsic duplicates in the same world (the same things at different times) could stand in a relation to each other at different times and have different qualities from those they had before the laws were changed.

Boyle also thinks that there can be a difference in qualities of intrinsic duplicates at the same (or different) time(s) in different worlds

[44] See McKitrick, 'Extrinsic Dispositions', 159, and Anstey, *Boyle*, 104. For Boyle, qualities are "extrinsic dispositions", i.e. ones which have all of the "marks of dispositionality" (e.g. manifestation conditions, etc.) but which are such that they could be had by one of a pair of intrinsic duplicates and not the other.

[45] The Boyle Papers, Royal Society Archives, London, vol. vii, fo. 113.

(perhaps '*in vacuo* worlds' or 'imaginary spaces'). We have seen this illustrated (implicitly) by the case of the lock and key, the gold and aqua regis case, etc.: in a different world, a world in which there are no keys, a schlock would not have aperitable qualities; in a world without aqua regis, gold would not be dissolvable, etc.

It is uncontroversial that Boyle thinks that qualities necessarily involve relations. But what *are* relations according to Boyle? Frankly, I don't know, but in my defence, it is not my fault: Boyle simply never gives an explicit account of the ontological status of relations.[46] But what he does say, while not helping with the question of the ontological status of relations, does help when thinking about the relationship between mechanical affections, relations, and qualities. He says that a change in the mechanical affections of a body can bring about a change in the relations that that body will have: because qualities are 'Relative Attributes, one of these now-mentioned Alterations, though but mechanicall, may endow the Body is happens to, with new Relations both to the Organs of Sense, and also to some other Bodies, and consequently may endow it with additionall Qualities' (*Works*, vi. 282; see also vi. 529). And when Boyle discusses the corrosibility of certain metals, he explains what he means by saying that the '*Corrosibility* of Bodies is as well as their Corrosiveness a Relative thing … And this relative Affection, on whose account a Body comes to be corrodible by a *Menstruum*, seems to consist in *three* things, which all of them depend upon Mechanical Principles' (*Works*, viii. 472). The three things mentioned by Boyle which produce a body's corrosibility are the size of 'pores' (which allows the menstruum to get in between the corpuscles of the gold), the size and solidity of the corpuscles, and the cohesion of the corpuscles (*Works*, viii. 472–3). The mechanical affections of a body determine the *possible* relations it can stand in, and the existence of another body to which it actually stands in relation determines in which of the possible relations it *actually* stands. In the lock and key example from the 'Excursion', Boyle says that the aperitable quality 'was nothing new in the Lock, or distinct from the Figure it had before those Keyes were made' (*Works*, v. 310). And every other example in the 'Excursion' seems to reduce qualities to mechanical affections: the dissolvability of gold in aqua regis is 'not

[46] See Anstey, *Boyle*, ch. 4.

in the Gold any thing distinct from its peculiar Texture' (p. 310); the poisonousness of the peas 'is really nothing distinct from the Glass its self … as it is furnish'd with that determinate Bigness, and Figure of Parts, which have been acquir'd by Comminution' (pp. 311–12); and the "echo-quality" of a cave "is in It nothing else but the Hollowness of its Figure" (p. 319). And in general, Boyle says that '[Qualities] are not in the Bodies that are Endow'd with them any Real or Distinct Entities, or differing from the Matter its self, furnish'd with such a Determinate Bigness, Shape, or other Mechanical Modifications' (*Works*, v. 310). Moreover, because qualities depend on relations, and the variety of relations (both actual and merely possible) depend on the mechanical affections, we get an explanation of the texts in which Boyle seems to be claiming that a body's qualities are identical to its mechanical affections. The reductivist and identity passages are only stating that mechanical affections will play a major role (in fact, they will play the *only* role on the part of the individual body itself!) in determining in which relations that body will stand to other bodies.

4. THE 'CHIEFEST DIFFICULTY': DISPOSITIVE QUALITIES

Although the 'Excursion' (and its title) supports the view that qualities are not intrinsic features of bodies, that qualities arise in virtue of actual relations between bodies or between bodies and perceivers, Boyle seems to undermine this view in a passage in *OFQ* in which he addresses a difficulty for his relative notion of qualities—which *importantly* he thinks is not a problem *simply* for his relative view of qualities; rather the difficulty is 'the chiefest, that we shall meet with against the Corpuscular Hypothesis' (*Works*, v. 317). The implication is that Boyle believes that his relative theory of qualities is entailed by corpuscularianism. It is not clear that corpuscularianism entails the relative view of qualities (for instance, it seems that a corpuscularian could hold that qualities are identical to mechanical affections; and as such, bodies could have qualities even in the absence of actual relations[47]). In any case, because we are interested in a problem that

[47] Perhaps this is not an option, given Boyle's explicit characterization of corpuscularianism (discussed below).

arises for Boyle, what is important is that *Boyle* thinks that the relative view of qualities is entailed by corpuscularianism.

Here is the objection Boyle proposes to himself:

> whereas we explicate Colours, Odours, and the like Sensible qualities, by a *relation to our Senses*, it seems evident, that they have an *absolute* Being irrelative to *Us*; for, Snow (for instance) would be white, and a glowing Coal would be hot, though there were no Man or any other Animal in the World: and 'tis plain, that Bodies do not onely by their Qualities work upon *Our senses*, but upon *other*, and those, Inanimate *Bodies*; as the Coal will not onely heat or burn a *Man's hand* if he touch it, but would likewise heat Wax, (even so much as to melt it, and make it flow) and thaw Ice into Water, though all the Men and sensitive Beings in the World were annihilated. (*Works*, v. 317)

The relative view of qualities given by Boyle in the 'Excursion' entails that if there were no perceivers or other bodies[48] in the world, a body would not have any qualities. The objection is perfectly general, and does not concern only sensible qualities: if Boyle's relative view of qualities is right, then in the absence of the relatum, nothing would be white, cold, fragile, dissolvable in aqua regis, and so on for any other putative quality.

In an initially surprising move, Boyle does not bite the bullet and simply say, what should be expected, given both the theory of relative qualities and the case of the lonely corpuscle: 'That is right: without actual relations a body would not have any qualities but only mechanical affections. Didn't you read later on in *OFQ* (*Works*, v. 334), where I say that the mechanical affections are ''the [only] Affections that belong to a Body, as it is consider'd in it self, without relation to *sensitive* Beings, or to other Natural Bodies''?' Instead he agrees with the hypothetical objector: 'I do not deny, but that Bodies may be said, *in a very favourable sense*, to have those Qualities we call Sensible, though there were no Animals in the World' (*Works*, v. 318–19; my emphasis).[49] He then introduces something that seems

[48] See Frederick O'Toole, 'Qualities and Powers in the Corpuscular Philosophy of Robert Boyle', *Journal of the History of Philosophy*, 12 (1974), 295–315, at n. 23, and *Works*, v. 334.

[49] A lot would seem to rest on the meaning of 'favourable' here. According to the *OED*, in this context, it means ''allowable''. However, the text cited as a use of the term in this sense is the very text from Boyle we are presently considering! Not very helpful.

to undermine much of what he has said before about qualities: the notion of a body having a quality *dispositively*:

> so, if there were no Sensitive Beings, those Bodies that are now the Objects of our Senses, would be but *dispositively*, if I may so speak, endow'd with Colours, Tasts, and the like; and *actually* but onely with those more Catholick Affections of Bodies, Figure, Motion, Texture, &c. (*Works*, v. 319)

What does Boyle mean by having a quality dispositively? He says that a body has a quality dispositively 'in its having such a disposition of its Constituent Corpuscles that, *in case it were duely apply'd* to the Sensory of an Animal, *it would produce* such a sensible Quality, which a Body of another Texture would not' (*Works*, v. 319; my emphasis).[50] And in *Men's Great Ignorance*, Boyle gives a similar account, while explicitly not restricting it to the sensible qualities he discusses in *OFQ*. In fact, he even uses the example of the lock and key again: 'if there were no such Objects in the World, those Qualities, in the Bodies that are said to be endow'd with them, would be but Aptitudes to work such Effects, in case convenient Objects were not wanting' (*Works*, vi. 521–2).

Dispositive qualities appear to be had by a body when two conditions are met: first, when a relatum, which would endow the body with an actual quality, does not exist; second, when certain counterfactuals are true of the body. But then dispositive qualities are consistent with the improbability (impossibility?) of the manifestation conditions for that quality. A piece of gold would have the dispositive quality of *dissolvability in aqua regis* even if there were no aqua regis in the world. And Boyle claims that dispositive qualities are qualities 'in a very favourable sense'. How can he possibly say this? Moreover, in addition to undermining Boyle's theory of relative qualities, other problems arise. First, for Boyle (actual) qualities have both explanatory and predictive power in corpuscularian natural philosophy. But it seems that dispositive qualities—if they tell us what a body would do, if it were to act upon or to be acted upon by another body—would do all of the same work in an explanatorily adequate natural philosophy.

[50] As Peter Anstey correctly points out, Boyle uses the term ''disposition'', as was common in the 17th century, in two different ways. He uses it most often to refer to the manner in which a body is arranged (i.e. its ''texture'') (e.g. *Works*, ii. 100, 108; iv. 26; vi. 288; viii. 449); and he uses it to refer to an ability, capacity, power that a body has in virtue of its mechanical affections (*Works*, ii. 24, 102; iv. 33; vi. 526; viii. 337, 449). In the passage just quoted, Boyle is using it in the former sense.

And if that were the case, then corpuscularian natural philosophy doesn't need actual qualities. Boyle himself states that among the conditions of any excellent hypothesis is the following: 'That it be the Simplest of all the Good ones we are able to frame, at lest Containing nothing tht is Superfluous or Impertinent.'[51] But if actual qualities were superfluous, then the corpuscularian philosophy would not be excellent. Second, Boyle's attack on the Grand Mistake of the scholastics depends on the truth of the relative theory of qualities. If qualities can be had *in a very favourable sense*, in the absence of relations, then it is unclear how the 'Excursion' would constitute an argument against the scholastic real qualities. Finally, Boyle thinks that the relative view of qualities is *entailed* by corpuscularianism. If the relative view of qualities is expendable, then corpuscularianism entails an expendable theory of qualities! All three of these consequences would be bad for Boyle. If Boyle is going to make so much rest upon his relative theory of qualities and ARR, then it seems that the admission of dispositive qualities is detrimental to his project.[52]

5. EXPERIMENTALISM AND ANTI-APRIORISM

Boyle says very little about dispositive qualities, and even less about how their admission does not undermine his theory of relative qualities. In fact, we've seen that one of his responses to the 'chiefest difficulty' is a simple admission that there are dispositive qualities. Boyle apparently does not think that dispositive qualities are incompatible with the theory of relative qualities. Surely there are reasons for Boyle's calm confidence in the face of the 'chiefest difficulty'. Boyle mentions several considerations concerning the 'chiefest difficulty', some of which seem irrelevant to the issue. The third consideration concerns the ''situatedness'' of bodies with actual qualities. He says:

> the actions of particular Bodies upon one another must not be barely æstimated, as if two Portions of Matter of their Bulk and Figure were plac'd

[51] 'Notes on a Good and an Excellent Hypothesis', 119.

[52] Of course, both actual qualities and dispositive qualities are *specified relatively*: talk of both will involve reference to a relatum. The difference between the two is that the relatum specified in an attribution of an actual quality must *exist*, whereas the relatum in an attribution of a dispositive quality does *not* exist. So, *specifying* a property by appeal to a relatum does not guarantee that it is an *actual* quality.

in some imaginary Space beyond the World, but as being scituated in the World, constituted as it now is, and consequently as having their action upon each other liable to be promoted, or hindered, or modify'd by the Actions of other Bodies besides them. (*Works*, v. 318)

The situatedness of bodies comes up in many other texts. For instance:

I shall observe that when we are considering how numerous and various Phænomena may be exhibited by mixt bodies, we are not to look upon them precisely in themselves, that is, as they are portions of Matter, of such a determinate nature, or Texture; but as they are parts of a World so constituted as ours is, and consequently as portions of Matter which are plac'd among many other Bodies. (*Works*, vi. 272; see v. 321; vi. 272, 275, 281)

Why is the situatedness of bodies relevant to our issue? I believe that the importance placed on situatedness illustrates Boyle's well-known commitment to natural philosophy, where this is understood, among other things, as an attempt to explain (and predict) the behaviour of bodies in *this* world, a world in which bodies are not in an "imaginary space" or an "*in vacuo* world", but rather a world in which bodies in fact have quality-endowing relations, and in which it is the business of the natural philosopher to discover these qualities. Unfortunately, Boyle does not seem to be addressing the issue of dispositive qualities: this consideration only explains why Boyle would appeal to situatedness to explain why bodies in fact have the actual qualities they do, but it does not explain why Boyle thinks that dispositive qualities would be had by bodies, in a very favourable sense, even in *in vacuo* worlds. We would think that if Boyle appeals to situatedness to explain the having of qualities, then dispositive qualities would not be qualities at all (and ultimately this is Boyle's view). But if so, it remains peculiar that Boyle says that dispositive qualities are qualities in a favourable sense. *By itself* the situatedness of bodies does not help address the worries arising from dispositive qualities. However, as we will see shortly, situatedness is a necessary feature of corpuscularianism as Boyle thinks of it, and the latter helps address our present concerns.

The key to reconciling Boyle's relative qualities with his acceptance of dispositive qualities and to see how situatedness is relevant is to recognize the uncontroversial fact that Boyle is first and foremost a natural philosopher whose conclusions about qualities are grounded

in experiments not in a priori metaphysical philosophizing (see *Works*, vi. 407, viii. 322).[53] Boyle's endorsement of an experimental method, his desire to compile a Baconian "natural history" of qualities, and his opposition to a priori "system builders" is expressed throughout his writings. For instance:

> And truly, *Pyrophilus*, if men could be perswaded to mind more the Advancement of Natural Philosophy than that of their own Reputations, 'twere not methinks very uneasie to make them sensible, that one of the considerablest services that they could do Mankind, were to set themselves diligently and industriously to make Experiments, and collect Observations, without being over-forward to establish Principles and Axioms, believing it uneasie to erect such Theories as are capable to explicate all the Phænomena of Nature, before they have been able to take notice of the tenth part of those Phænomena that are to be explicated … That then that I wish for, as to Systems, is this, That men in the first would forbear to establish any Theory, till they have consulted with (though not a fully competent number of Experiments, such as may afford them all the Phænomena to be explicated by that Theory, yet) a considerable number of Experiments in proportion to the comprehensiveness of the Theory to be erected on them. (*Works*, ii. 13–14)

The experimental natural philosopher will discover the qualities of bodies and how bodies behave, 'such as without the diligent Examination of particular Bodies would, I fear, never have been found out *à priori* ev'n by the most profound Contemplators' (*Works*, ii. 24). And Boyle wishes 'chiefly to keep my Judgment as unprepossess'd as

[53] It should be noted that recently the relationship between Boyle's corpuscularianism and his experimentalism has been questioned in Alan Chalmers, 'The Lack of Excellency of Boyle's Mechanical Philosophy', *Studies in History and Philosophy of Science*, 24 (1993), 541–64. Chalmers argues both that Boyle's success as an experimental scientist was not aided by his corpuscularianism and that his corpuscularianism was not supported by his experiments. An adequate response to these claims deserves more space than I have here and would take us too far away from our topic. For some responses to Chalmers, see Andrew Pyle, 'Boyle on Science and the Mechanical Philosophy: A Reply to Chalmers' ['Boyle on Science'], *Studies in History and Philosophy of Science*, 33 (2002), 175–90; Anstey, *Boyle*; and Anstey, 'Robert Boyle and the Heuristic Value of Mechanism' ['Heuristic Value'], *Studies in History and Philosophy of Science*, 33 (2002), 161–74. What is important for *my* purposes is the fact that Boyle himself thinks that there is an intimate dependence-relation between experimentalism and corpuscularianism.

It has been pointed out by Anstey ('Heuristic Value'), however, that Boyle's corpuscularianism places certain non-experimental restrictions on the range of *possible* results from experimentation. For instance, Boyle would never entertain that an experimental result came from *qualitates reales* or scholastic substantial forms.

might be with any of the Modern Theories of Philosophy, till I were provided of Experiments to help me to judge of them' (*Works*, ii. 86).[54]

At times Boyle demonstrates his famous mild agnosticism and at other times his disparaging antagonism towards metaphysical issues and a priori reasoning in natural philosophy.[55] His well-known agnosticism concerning the nature of body and the origin of motion stems from his interest in the experimental fruitfulness of both Atomistic and Cartesian natural philosophy. In a famous passage from the Preface to *Some Specimens of an Attempt to Make Chymical Experiments Useful to Illustrate the Notions of the Corpuscular Philosophy*, Boyle states that the

> Atomical and Cartesian Hypotheses … might be look'd upon as one Philosophy … I know that these two sects of Modern Naturalists disagree about the Notion of Body in general, and consequently about the Possibility of a true Vacuum, as also about the Origine of Motion, the indefinite Divisibleness of Matter, and some other points of less Importance than these: But in regard that some of them seem to be rather Metaphysical than Physiological Notions, and that some others seem rather to be requisite to the Explication of the first Origine of the Universe, than of the Phænomena of it in the state wherein we now find it; in regard of these, I say, and some other Considerations, and especially for this Reason, That both parties agree in deducing all the Phænomena of Nature from Matter and local Motion. (*Works*, ii. 87)

Here Boyle states something repeated elsewhere (e.g. *Works*, v. 292), namely that he is much less interested in the metaphysical differences dividing the sects of mechanical philosophers than in what they have in common, namely a rejection of scholastic substantial forms, *qualitates reales*, and teleological natural explanations, and their appeal to the mechanical features of small bits of matter to explain all natural phenomena.[56]

[54] See also *Works*, v. 288, 292, 299, and Rose-Mary Sargent, 'Learning from Experience: Boyle's Construction of an Experimental Philosophy', in Hunter (ed.), *Robert Boyle Reconsidered*, 58–9.

[55] See Richard Arthur, 'The Enigma of Leibniz's Atomism', *Oxford Studies in Early Modern Philosophy*, 1 (2003), 183–227; Marie Boas, 'The Establishment of the Mechanical Philosophy' ['Establishment'], *Osiris*, 10 (1952), 412–541; Pyle, 'Boyle on Science'; Anstey, *Boyle*; Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle and the Experimental Life* [*Air-Pump*] (Princeton: Princeton University Press, 1985).

[56] See also *Works*, v. 354; Anstey, *Boyle*, 92; Sargent, 'Learning from Experience', 69.

Most importantly for present purposes is Boyle's own explicit characterization of the corpuscular philosophy:

> when I speak of the *Corpuscular* or *Mechanical* Philosophy … I plead only for such a Philosophy, as reaches but to things purely Corporeal, and distinguishing between the first *original of things*; and the subsequent *course of Nature*, teaches, concerning the *former*, not onely that God gave Motion to Matter, but that in the beginning He so guided the various Motions of the parts of it, as to contrive them into the World he design'd they should compose … and established those *Rules of Motion*, and that order amongst things Corporeal, which we are wont to call the *Laws of Nature*. And having told this as to the *former*, it may be allowed as to the *latter* to teach, That the Universe being once fram'd by God, and the Laws of Motion being settled and all upheld by His incessant concourse and general Providence; the Phænomena of the World thus constituted, are Physically produc'd by the Mechanical affections of the parts of Matter, and what they operate upon one another according to Mechanical Laws. (*Works*, viii. 103–4)

Boyle's characterization of corpuscularianism wears on its face its anti-a priori method,[57] the importance of situatedness, the importance of discovering how actual things actually behave,[58] and its concern only with *our* corporeal world. He is concerned with how *our world* works, not how any possible world works (see *Works*, v. 318, 321; vi. 272, 275), and our world is one in which bodies are in fact situated and which has its own contingent natural laws. The natural philosopher should concern himself with explanation of how *those* bodies behave: 'all whom [i.e. atomists and naturalists in general] I wish, that though men cannot perhaps in all things, yet at least as far as they can, they would accustom themselves to speak and think as Nature does really and sensibly appear to work' (*Works*, ii. 108). And in the unpublished 'Of Naturall Philosophie',[59] Boyle lists two 'Principles of naturall Philosophie', the second of which is 'That it is requisite

[57] See Boas, 'Establishment', 487–8, 492; Sargent, 'Learning from Experience', 69; Keating, 'Un-Locke-ing Boyle', 321.

[58] See *Works*, iii. 256: 'For it is one thing to be able to shew it possible for such and such Effects to proceed from the Various Magnitudes, Shapes, Motions, and Concretions of Atoms, and another thing to be able to declare what precise, and determinate Figures, Sizes, and Motions of Atoms, will suffice to make out the propos'd *Phænomena*, without incongruity to any others to be met with in Nature.'

[59] Boyle papers, vol. xxxvi, fos. 65–6.

to be furnished with observations at [*sic*] Experiments'. And among the list of 'Reasons of which take these Observations' are '(1) That we consult nature to make her Instruct us what to beleeve not to confirme what we have beleeved,' and '(5) That therefore Reason is not to be much trusted when she wanders far from Experiments & Systematicall Bodyes of naturall Philosophie are not for a while to be attempted.'

Boyle's experimental method and his opposition to apriorism in natural philosophy is, of course, well known,[60] and perhaps accounts both for his relative neglect by contemporary historians of philosophy and for the overwhelming amount written on Boyle by historians of science. Given that this is well-explored territory, I will not dwell on it any longer. I wish only to emphasize its importance to Boyle's theory of qualities and its relevance to the issue of dispositive qualities. Even in *OFQ*—the most 'metaphysical' of his treatment of qualities—Boyle's views about the qualities of bodies are intended to be supported by his experimental work.[61]

Boyle thinks that the natural philosopher knows how things in the corporeal world behave by knowing as many qualities of bodies as he can; and given the prominent role of experiment and Boyle's disparaging remarks about the a priori speculation of 'systematic' philosophers, the qualities of bodies are not known except by observation. Moreover, because Boyle thinks that we may be ignorant of indefinitely many qualities a body has, in order to know that a body has a particular quality, we must observe the *manifestation* of that quality. Proper observation of a quality just is the observation of its manifestation along with recognition of the relevant manifestation conditions. For example, we cannot know that gold has the quality of *dissolvability in aqua regis* unless we have observed some gold actually

[60] For instance, John Henry, 'Occult Qualities and the Experimental Philosophy: Active Principles in Pre-Newtonian Matter Theory', *History of Science*, 24 (1986), 335–81; Shapin and Schaffer, *Air-Pump*; Boas, 'Establishment'; Sargent, 'Learning from Experience'; Michael Hunter, 'How Boyle Became a Scientist', *History of Science*, 33 (1995), 59–103; Clericuzio, *Elements*.

[61] In fact, the Second Part of *OFQ* (*Works*, v. 356–442) is devoted to the discussion of experiments supporting the theory of qualities discussion in the First, or 'Theoretical', Part. When talking about qualities, Boyle is talking about qualities, 'whose Existence I can manifest, not only by considerations not absurd, but also by real Experiments and Physicall *Phænomena*' (*Works*, vi. 289).

dissolving in aqua regis. So, in our present world, a world in which gold is actually dissolvable in aqua regis, we cannot know what the gold *would* do if immersed in aqua regis unless we have observed an instance of gold dissolving in aqua regis.

Because Boyle thinks that only situated bodies have actual qualities, it then follows that knowledge of a body's actual qualities requires that that body is situated. Now, for Boyle, the difference between whether a body at a time has an actual quality or a dispositive quality consists primarily in whether the body in question stands in a quality-constituting relation. But whether a body stands in such a relation at *t* shouldn't affect the manner in which we *know* what that body at *t would* do in certain circumstances. In *any* case, to know what a body would do, we must have observed a manifestation of an actual quality.

We are now in a position to see that actual qualities, which can only be had when certain relations obtain, are completely indispensable to the attribution of dispositive qualities to bodies. That is, not only do dispositive qualities *not* make actual qualities dispensable, their attribution in fact makes actual qualities indispensable. First, however, we need to spell out in more detail what dispositive qualities are, and we must recognize the situations in which Boyle thinks that the issue of dispositive qualities arises; that is, the situations which would lead us even to think about a body's dispositive qualities. Here is what Boyle says:

> it seems evident, that they [i.e. sensible qualities] have an *absolute* Being irrelative to *Us*; for, Snow (for instance) would be white, and a glowing Coal would be hot, though there were no Man or any other Animal in the World … the Coal will not onely heat or burn a *Man's hand* if he touch it, but would likewise heat Wax … and thaw Ice into Water, though all the Men, and sensitive Being in the World were annihilated. (*Works*, v. 317)[62]

As this and other texts make clear, dispositive qualities become an issue in (roughly) two kinds of situation: (1) when a relevant relatum ceases to exist;[63] (2) when we imagine counterfactual situations in

[62] The explicit discussion of dispositive qualities in *OFQ* mainly concerns *sensible* qualities. But as I have already mentioned, this phenomenon is not peculiar to sensible qualities, but relates to all qualities. In the case of many sensible qualities, the quality-constituting relatum must be a perceiver, or 'sensitive Being'.

[63] Indicated by the example of the pin and the corpse (*Works*, v. 319–20), as well as implicitly by the discussions of the lock and key: if we altered a key that previously had an aperitive quality in relation to the lock, then the lock dispositively has the aperitable quality.

which the quality-constituting relation is absent (see e.g. *Works*, v. 317, 319). In these sorts of situation, however, there are constraints imposed by Boyle's theory of relative qualities: we are presently in an epistemic situation in which we know, for instance, that gold is actually dissolvable in aqua regis, but we are imagining what gold would be like in case aqua regis (which, if it were to exist, would endow the body with an actual quality) were not to exist. Now consider six worlds, each of which contains some gold and is the same as our world with respect to laws of nature and other relevant considerations except when specified:

(W_1) Never any aqua regis.
(W_2) No aqua regis at t_1; some aqua regis at t_2; gold immersed in aqua regis at t_2; immersion and dissolving observed; no aqua regis at t_3.
(W_3) No aqua regis at t_1; some aqua regis at t_2; gold never immersed in aqua regis; no aqua regis at t_3.
(W_4) No aqua regis at t_1; some aqua regis at t_2; gold immersed in aqua regis at t_2; immersion and dissolving *not* observed; no aqua regis at t_3.
(W_5) Aqua regis all the time; no immersion of gold.
(W_6) Aqua regis all the time; immersion and dissolving of gold observed at t_2.

We can say the following about Boyle's *actual* qualities in these worlds: According to ARR, the bare minimum required for the existence of an actual quality is the existence of all of the relata of a quality-constituting relation. So, in W_1 there is no actual quality: if there never is any aqua regis, then gold is never dissolvable in aqua regis. And again considering ARR, according to which contemporaneousness is both necessary (and sufficient in this case, given my stipulation about the transworld constancy of laws and other relevant relata) for a quality-constituting relation, in W_2–W_4 there is no actual quality at t_1; there is at t_2; and there is not again at t_3. If there was some aqua regis at one time but no longer any, then gold had the quality at one time but lacks it now. The situations in W_5 and W_6 are as straightforward as in W_1: if the relevant relatum is always present, then the quality is always present. Remember that Boyle does not think that having a quality requires a manifestation of that quality; also, recalling a point

I made earlier, Boyle thinks that a body can have a huge number of qualities of which we are totally ignorant.

So much for the ontological situation in these worlds, but now consider the epistemic situation. Obviously, we cannot know that a body has a quality in a world in which it does not have that quality; so in W_1 we don't know that gold is dissolvable in aqua regis. Given that both manifestation of a quality and observation of the manifestation are necessary in order to know that a body has a certain quality, in W_3, W_4, and W_5 we are ignorant of the gold's dissolvability, despite the fact that gold actually has that quality at least some of the time. W_6 is a world in which we know that gold is dissolvable owing to the manifestation and observation of the manifestation of that quality. But what about W_2, the most interesting world for our purposes? As we have already seen, gold lacks the actual quality at t_1 (because it fails to satisfy ARR's contemporaneousness condition); gold has the actual quality at t_2 (because it satisfies ARR at t_2); but gold again lacks the actual quality at t_3 (because it fails to satisfy the contemporaneousness condition). But at t_3 we know, in virtue of manifestation and observation, that gold actually had that quality at t_2. We know at t_3 what gold *would* do if there were some aqua regis and the gold were immersed in it. What we say, then, is that gold is *dispositively* dissolvable in aqua regis at t_3.

Now consider these intrinsic duplicates, these pieces of gold, at t_4, a time after t_3. Do the pieces of gold differ in their dispositive qualities at t_4? I believe that Boyle thinks so: of the three pieces of gold, only the piece in W_2 has *dispositive* dissolvability at t_4, and at t_4 in W_3, W_4, W_5, and W_6, the gold lacks dispositive dissolvability. (The gold in W_6 lacks dispositive dissolvability because dispositive qualities require the *absence* of the relevant relatum; otherwise it is unclear how dispositive qualities would differ from *actual qualities*, and it is stipulated that the relevant relatum is always present in W_6.)

Before I defend this claim about Boyle's dispositive qualities, let me address an initial objection with significant prima facie weight against my interpretation:

> Listen, Boyle characterizes dispositive qualities solely in terms of counterfactuals and the absence of relevant relata. Let me refresh your memory: Boyle says that dispositive qualities are 'such a

> disposition of its Constituent Corpuscles, that *in case it were duely apply'd* to the Sensory of an Animal, *it would produce* such a sensible Quality, which a Body of another Texture would not'. And 'if there were no such Objects in the World, those Qualities, in the Bodies that are said to be endow'd with them, would be but Aptitudes to work such Effects, in case convenient Objects were not wanting' (*Works*, vi. 521–2). Boyle even compares dispositive qualities to a lute's being in tune: 'we say that a Lute is in tune, whether it be actually plaid upon or no, if the Strings be all so duly stretcht, as that it would appear to be in Tune, if it were play'd upon' (*Works*, v. 319).[64] But, like the in-tune lute, certainly the pieces of gold in those worlds (at times when it is lacking actual dissolvability in virtue of the non-existence of aqua regis) have 'Aptitudes to work such Effect, in case convenient Objects were not wanting.' And pieces of gold have 'such a disposition of [their] Constituent Corpuscles' that, 'in case [they] we duely apply'd' to aqua regis, they *would* dissolve, whereas 'a Body of another Texture would not'. That is, they are such that *were* they immersed in aqua regis, they would dissolve. They are simply in the unfortunate situation of being in a world with aqua regis. But lack of aqua regis *plus* having the relevant true counterfactuals is sufficient, according to Boyle, for having *dispositive dissolvability in aqua regis*. So, how can you say that one of these pieces of gold has a dispositive quality (dispositive dissolvability in aqua regis) that the others lack? Either all the pieces have this dispositive quality or none of them do.

At first glance, there is some weight to this objection. Boyle, after all, *does* say the things quoted above, and it is true that the relevant counterfactuals are equally true of the pieces of gold in each of the worlds. Ultimately, however, I don't think this worry is detrimental to my interpretation of Boyle. I suggest that Boyle holds both that dispositive qualities are identical *in re* to a body's determinate mechanical affections—and in this "inappropriate" sense, both pieces

[64] In order to make the lute example relevant here, and not to attribute to Boyle an obvious confusion between having a quality and the manifestation of that quality, let us imagine that the lute is in a world in which there are no things that could play it. In this case, as with the other cases of dispositive qualities, the lute lacks *actual* in-tune-ness.

of gold will be dispositively dissolvable—*and* that (keeping the laws fixed) intrinsic duplicates can differ with respect to their dispositive qualities. By showing that Boyle holds the latter thesis and *how* he holds it will solve the problems stated earlier that dispositive qualities seem to pose for him.

Remember that Boyle thinks that there is a difference between a body actually having a quality and someone knowing that it has that quality. This can be due to many things, one of which is our ignorance of 'unheeded' or unknown relations. In the case of dispositive qualities, however, there are no such relations of which we could be ignorant. I want to suggest that in the case of dispositive qualities, there is not much of a difference between a body's having a dispositive quality and our knowing that it has that dispositive quality. That is, for Boyle dispositive qualities are simply mechanical affections known to behave in such-and-such a way in certain circumstances. Boyle says that a body has a dispositive quality when a relevant relatum is absent but when the body has 'such a disposition of its Constituent Corpuscles' such that it *would have* an actual quality if the relevant relatum existed. In this context, 'disposition' can only mean 'texture',[65] and texture is one of the mechanical affections of composite bodies. Given this, Boyle clearly thinks that dispositive qualities are identical *in re* to mechanical affections. But if that is right, then aren't dispositive qualities simply a body's determinate mechanical affections? Moreover, mechanical affections are both independent of and more fundamental than actual qualities.[66] So, isn't there a sense in which dispositive qualities would be more fundamental than and independent of actual qualities? Yes, in a sense, dispositive qualities are mechanical affections; but, no, they are not more fundamental than actual qualities even supposing that mechanical affections are more fundamental than actual qualities. Boyle, in a sense, identifies dispositive qualities with the mechanical affections, in particular the *texture* of a body (or a subset

[65] This is vindicated when Boyle says that 'a Body of another Texture would not' produce the same effect. But mostly noticeable is a passage we have already seen in which Boyle says that bodies with dispositive qualities are '*actually* [endowed] onely with those more Catholick Affections of Bodies, Figure, Motion, Texture, &c.'.

[66] They would be independent in the sense that it is possible for a body to have mechanical affections but no qualities; whereas it is impossible for a body to have qualities without mechanical affections. They would be more fundamental in the sense that, as Boyle repeatedly says, qualities 'flow from' and 'are deriv'd from' mechanical affections.

of the texture). As we have already seen, Boyle thinks that in the absence of relations, bodies would have only 'those more Catholick Affections of Bodies, Figure, Motion, Texture, &c.' (*Works*, v. 319). The mechanical affections are 'the Affections that belong to a Body, as it is consider'd in it self, without relation to *sensitive* Beings, or to other Natural Bodies' (*Works*, v. 334). Because dispositive qualities are had in the absence of a quality-constituting relation, they *could* be nothing else *in re* other than mechanical affections. Wouldn't we then say that a body, in virtue of the possibility of its having its mechanical affections prior to (or in the absence of) any actual relations, has all of its dispositive qualities? No. I suggest that, for Boyle, dispositive qualities are similar to *entia rationis*, i.e. they are identical *in re* to the mechanical affections, but prior to the observation of actual qualities, we cannot understand them to exist at all. Only in virtue of the observation of actual qualities of bodies can we understand what a body would do if the appropriate relation obtained. And, as we have seen, what a body would do in virtue of its mechanical affections if a certain relation obtained, *but which doesn't*, is just what we are talking about when we attribute a dispositive quality to it. Dispositive qualities and mechanical affections are thus identical *in re; in bodies*, the ''ground'' of dispositive qualities is the mechanical affections. Conceding this point, however, does not entail that *all there is* to dispositive qualities is mechanical affections. Boyle's dispositive qualities are, among other things, mechanical affections *known to behave in such-and-such a manner*. But because there are worlds in which this knowledge is absent or is present only after a certain time, but in which the relevant mechanical affections are present, dispositive qualities are not identical *simpliciter* to mechanical affections. Dispositive qualities are not a distinct *ontological or metaphysical* category. Dispositive qualities are, if you will forgive the scholastic language, *entia rationis* with a *fundamentum in re*, and their *fundamentum* is the mechanical affections.

If my interpretation is correct, then sense can be made of the pervasiveness of ''reductive'' passages in Boyle. For instance, Boyle says that the aperitive quality of the key is not 'distinct from the Figure'; the sensible qualities do not differ 'from the Matter its self, furnish'd with such a Determinate Bigness, Shape, or other Mechanical Affections' and 'there is in the Body, to which these Sensible Qualities are attributed, nothing of Real and Physical, but

the Size, Shape, and Motion, or Rest of its component Particles, together with that Texture of the whole'; gold's dissolvability in aqua regis is 'not in the Gold any thing distinct from its peculiar Texture'; the poisonousness of the ground glass in the nun's peas 'is really nothing distinct from the Glass its self … as it is furnish'd with that determinate Bigness, and Figure of Parts, which have been acquir'd by Comminution'; the echo-producing quality of the cave 'is in It nothing else but the Hollowness of its Figure'.[67] These texts certainly make it appear as though *actual* qualities are nothing more than mechanical affections. We have seen, however, that Boyle clearly denies this. Taking a cue from O'Toole, I think that all that Boyle is saying here is that *in the body*, there *is* nothing more to a quality other than its mechanical affections. That does not mean that mechanical affections are all there is to qualities: a body's mechanical affections plus other bodies or perceivers, as we have seen, determine which actual relations it stands in, and only when it stands in an actual relation do qualities come to be. The same goes for dispositive qualities: because, by definition, dispositive qualities are had only in the absence of a relatum that would endow a body with an actual quality, they can be 'nothing in the body' other than its mechanical affections. But as with actual qualities, there is more to the story than just mechanical affections. The rest of the actual-qualities story (i.e. existence of a relevant relatum) cannot, however, be the rest of the story with dispositive qualities. Nevertheless, because of Boyle's ''reductive'' remarks about actual qualities, despite there being more to an actual quality than just what there is *in* the body, the fact that Boyle claims that dispositive qualities are identical *in re* to mechanical affections, it doesn't follow that dispositive qualities are nothing more than mechanical affections. It follows, just as it does with actual qualities, that the ''something more'' must be *extrinsic* to the body. In the case of actual qualities, the extrinsic feature is the relatum external to the body's mechanical affections; in the case of dispositive qualities, the extrinsic feature is our manner of thinking about the body's mechanical affections.

[67] The fact that Boyle sometimes says that these qualities are nothing 'real' in bodies other than mechanical affections, clearly indicates that they are not *qualitates reales*, as Anstey (*Boyle*) has pointed out. Nevertheless, these passages do seem to indicate a form of reductionism in Boyle.

I realize that Boyle never explicitly says that dispositive qualities are *entia rationis*. But he *does* explicitly hold that (*a*) dispositive qualities are identical *in re* to mechanical affections; (*b*) knowledge of qualities is the most important thing for natural philosophers; (*c*) this knowledge is had only when there is an observation of a manifestation of an actual quality. Dispositive qualities, therefore, carry more conceptual baggage than the mechanical affections. To see that Boyle believes that it is possible for x to involve a conceptual component that y lacks, even though x is identical *in re* to y, consider a precedent for this way of thinking in Boyle. Boyle, and Locke after him, hold a conventionalist account of essences, kinds, or species. I will discuss Boyle's theory of kinds shortly, but for now, we need only recognize one aspect of his theory. More often than not, both Boyle and Locke use the term ''property'' as a technical term from the Aristotelian five predicables: a property is a 'proprium', an attribute that is not part of the essence or definition of a species, but which is entailed by that essence or definition.[68] Boyle and Locke use this term in a slightly different manner to refer to any quality that is essential to a kind of thing or, derivatively, is essential to an individual in so far as it is a member of a certain kind. Boyle and Locke think that, for any kind or species, *we* decide, on the basis of observable similarities between individuals, which qualities will be included in the set of qualities necessary for inclusion in that kind or species.[69] A certain colour,[70] for instance, can be a quality at one time and a property at another; or it can be a quality of individuals of one kind and a property of individuals of another kind. Yellowness is a *quality* of some horses, but it is a *property* of gold.[71] Properties,

[68] Porphyry's *Isagoge* (in Paul Vincent Spade (tr. and ed.), *Five Texts on the Mediaeval Problem of Universals* (Indianapolis: Hackett, 1994), 10): a *proprium* is 'what occurs in the whole species, in it only, and always, as the capacity to laugh in man'. See also D. P. Henry, 'Predicables and Categories', in Norman Kretzmann, Anthony Kenny, and Jan Pinborg (eds.), *Cambridge History of Later Medieval Philosophy* (Cambridge: Cambridge University Press, 1982), 128–42.

[69] For detailed discussion of this issue in Locke, see Dan Kaufman, 'Locke on Individuation and the Corpuscular Basis of Kinds' ['Locke on Individuation'], *Philosophy and Phenomenological Research* (forthcoming).

[70] Colour is perhaps not the best example because there are scholars who think that colour is not a quality at all for Boyle or Locke. I believe they are right about Locke. However, the textual evidence that Boyle thinks that colours are qualities is overwhelming.

[71] '... and though an Accident can be but accidental to Matter, as it is a Substantial thing, yet it may be essential to this or that particular Body ... though Roundness is but

however, are *not* a new ontological category: they are simply *qualities-considered-in-a-certain-way*, namely as being essential to a kind. I think that Boyle's dispositive qualities are like Boylean–Lockean *propria*, in this respect: They are *mechanical-affections-considered-in-a-certain-way*. Of course, there are dissimilarities between the case of *propria* and the case of dispositive qualities. I merely wish to call attention to the fact that there are other aspects Boyle's thought in which he embraces things that are identical *in re* despite being conceptually (and temporally) distinct. Just as a quality can be a property at one time but not at another time, so too can something be a mechanical affection at one time but a dispositive quality at another.[72]

Boyle is not, however, drawing metaphysical conclusions from epistemic considerations; he is not claiming that there is another genuine kind of qualities (dispositive qualities) based on what we know about actual qualities. Rather, dispositive qualities are simply the mechanical affections *considered in a certain way*. And because the way in which the mechanical affections must be considered in order to count as dispositive qualities requires observation of the manifestation of an actual quality, this conceptual component enters the scene *after* both the mechanical affections and the actual qualities which depend on the mechanical affections.

Direct evidence for my interpretation of Boyle is admittedly scarce, partly because Boyle doesn't discuss *what* dispositive qualities *are* in any great detail, and partly because my interpretation is based on inferences from his general method to a particular application of that method—an application that he does not explicitly make. However, in Boyle's own response to the chiefest difficulty, he says the following: 'if there were no Sensitive Beings, those Bodies that are *now* the Objects of our Senses, would be but *dispositively*, if I may so

Accidental to Brass, yet 'tis Essential to a Brasen Sphære; because, though the Brasse were devoid of Roundnesse, (as if it were Cubical, or of any other figure,) it would still be a Corporeal Substance, yet without that Roundness it could not be a Sphære' (*Works*, v. 324). Sometimes Boyle calls properties 'essential modifications': 'a *Modification*, because 'tis indeed but a Determinate *manner of Existence* of the Matter, and yet an *Essential Modification*, because that though the concurrent Qualities be but Accidental to Matter, (which with others instead of Them, would be Matter still,) yet they are *essentially necessary* to the Particular *Body*, which without those Accidents would not be a Body of that Denomination, as a *Mettal* or a *Stone*, but of some other' (*Works*, v. 334).

[72] This, of course, is not say that a quality (or mechanical affection) ceases to be a quality (or mechanical affection) once it "becomes" a property (or dispositive quality).

speak, endow'd with Colours, Tasts, and the like' (*Works*, v. 319; first emphasis mine).[73] I take the reference to the bodies that are *now* the objects of our senses to indicate that Boyle thought that dispositive qualities are attributed on the basis of what is actually the case *now*. That is, given the way the world is now, a world in which snow is actually white and gold is actually dissolvable in aqua regis, we may, imagining perceivers and aqua regis to disappear, attribute dispositive qualities to snow and gold. In cases both of imagined counterfactual situations and of a no-longer-existing relatum, dispositive qualities are attributed on the basis of what is actually known to be the case in our world at the present time. Because snow has previously caused the sensation of whiteness in a perceiver, and because coal has previously melted wax, we are now in a position to say what *would* be the case if perceivers and wax ceased to exist *and* if (keeping the laws fixed) there never were perceivers or wax. In other words, we are now in a position to attribute a dispositive quality.

We have already seen that Boyle's theory of kinds provides a precedent for things that are conceptually distinct yet identical *in re* in his ontology. His theory of kinds, furthermore, provides additional evidence, *powerful* evidence, for my interpretation of the relationship between actual and dispositive qualities in Boyle. A close reading of Boyle's discussion of dispositive qualities reveals something quite important: he only mentions dispositive qualities as belonging to *kinds* of things or to individual members of a kind. (This is true even in the 'Excursion', as we will see.) When addressing the chiefest difficulty and explicitly discussing dispositive qualities, he speaks of the dispositive qualities of *snow, coal, soot*, and *pins* (*Works*, v. 317, 319). This may seem like a small matter, but it is important to our discussion because these are kinds, and Boyle is a conventionalist about kinds in much the same way as Locke after him.[74] The following passages are representative of Boyle's view of kinds:

[73] See *Works*, v. 321, where Boyle also emphasizes the importance of 'a World constituted as ours *now* is' (my emphasis).

[74] I cannot go into detail here, so the following will have to suffice for now: when I say that Boyle is a conventionalist about kinds I mean that he rejects both Aristotelian essences and qualitatively identical corpuscular arrangements in each member of a kind, and that he thinks that it is *we* who decide which of the many objective similarities between individuals are *properties* of a kind. For a detailed examination of Locke's account of kinds,

observing many Bodies to agree in being Fusible, Malleable, Heavy, and the like, they gave to that sort of Body the name of *Mettal*, which is a *Genus* in reference to Gold, Silver, Lead, and but a *Species* in reference to that sort of mixt Bodies they call *Fossilia* … I observe that if (for Instance) You ask a Man, what Gold is, if he cannot shew you a piece of Gold, and tell You, This is Gold, he will describe it to You as a Body, that is extremely Ponderous, very Malleable and Ductile, Fusible and yet Fixt in the Fire, and of a Yellowish colour: and if You offer to put off to him a piece of Brass for a piece of Gold, he will presently refuse it, and (if he understand Mettals) tell You, that though Your Brass be coloured like it, 'tis not so heavy, nor so malleable, neither will it like Gold resist the utmost brunt of the Fire, or resist *Aqua Fortis*: And if You ask Men what they mean by a Ruby, or Niter, or a Pearl, they will still make You such Answers, that You may clearly perceive, that whatever Men talk in Theory of Substantial Forms, yet That, upon whose account they really distinguish any one Body from others, and refer it to this or that *Species* of Bodies, is nothing but an Aggregate or Convention of such Accidents, as most men do by a kind of Agreement (for the Thing is more Arbitrary than we are aware of) think necessary or sufficient to make a Portion of the Universal Matter belong to this or that Determinate *Genus* or *Species* or Natural Bodies. (*Works*, v. 322–3)

… an Aggregate or Convention of Qualities is enough to make the portion of Matter 'tis found in, what it is, and denominate it of this or that Determinate sort of Bodies … For such a Convention of Accidents is sufficient to perform the Offices that are necessarily requir'd in what Men call a Forme, since it makes the Body such as it is, making it appertain to this or that Determinate Species of Bodies, and discriminating it from all other Species of Bodies whatsoever: as for Instance, Ponderousness, Ductility, Fixtness, Yellowness, and some other Qualities, concurring in a portion of Matter, do with it constitute Gold, and making it belong to that Species we call Mettals, and to that sort of Mettals we call Gold, do both denominate and discriminate it from Stones, Salts, Marchasites, and all other sorts of Bodies that are not

see Kaufman, 'Locke on Individuation'. It must also be noted that Boyle does sometimes talk about the *nature* of certain bodies apart from the collection of qualities we use to distinguish kinds. This may seem to indicate that he was more of a realist than he seems to be. However, in those passages, he uses the term "nature" to refer to its collection of mechanical affections, its "corpuscular microstructure", or *texture, not* to the kind or species to which an individual belongs. This is especially noticeable in 'An Introduction to the History of Particular Qualities', where Boyle mentions 'portions of Matter, of such a determinate nature or Texture' (*Works*, vi. 272). So, when he discusses the *nature* of a body, irrespective of the kind of which it is a member, he should be taken to mean its texture and nothing more.

Mettals, and from Silver, Brass, Copper, and all Metals except Gold. (*Works*, v. 324; see also v. 328, 332, 334–5; vi. 279)

On the basis of observable similarity of qualities between individuals, we pick out certain of the similar qualities as essential to the kind or species of thing to which individuals similar with respect to *those* qualities belong. After that the qualities (now *properties* with respect to the species) that belong to a kind is largely a matter of convention or 'a kind of Agreement'.[75]

Boyle's theory of kinds is lurking even in the lock and key example in the 'Excursion'. He carefully avoids calling the schlock a 'lock'; instead he says it 'was onely a Piece of Iron, contriv'd into such a Shape', and the key too 'was nothing but a Piece of Iron of such a Determinate Figure' (*Works*, v. 310).[76] But once the lock gains the aperitable quality, 'it became a Main part of the Notion and Description of a Lock'. The aperitable quality is now a *property* of the kind *Lock*. Likewise, when discussing the invention of a new menstruum that will partially dissolve and partially transmute gold, Boyle says, 'there will then arise another new Property, whereby to distinguish [gold] from other Mettals' (*Works*, v. 311). The use of the term ''property'' is very telling: here, as elsewhere, collections of properties are what distinguish individuals of one kind from individuals of another kind, and properties are qualities that are considered essential to a particular kind.

How does Boyle's theory of kinds support my interpretation of the relationship between actual and dispositive qualities and mechanical affections? Boyle attributes dispositive qualities only to *kinds* (or individual members of kinds), and kinds are formed by picking among similar actual qualities (and not merely actual qualities, because Boyle thinks that there are a huge number of *unobserved* qualities a body may have, but *observed* actual qualities), and then kinds are perpetuated by convention. It follows that nothing could be a member of a kind without having (or having had at some

[75] For a recent discussion of Boyle's theory of kinds, see Jan-Erik Jones, 'Boyle, Classification and the Workmanship of the Understanding Thesis', *Journal of the History of Philosophy*, 43 (2005), 171–83.

[76] Of course, *iron* is a kind, but it is not a kind that has the aperitable quality as a property. Boyle thinks that a quality of x can be merely a quality in so far as x is an F, but can be a property in so far as x is a G; see the quotation in n. 71.

time) actual qualities. And if dispositive qualities are had only by kinds or members of kinds, as Boyle's discussion of the chiefest difficulty indicates, then there are no dispositive qualities without there having been actual qualities. Once again, we see that, in Boyle, there is an asymmetrical dependence of dispositive qualities on actual qualities: something could have actual qualities without being a member of a kind at all; therefore, something could have actual qualities without dispositive qualities, whereas something could not have dispositive qualities without having or having had actual qualities.

CONCLUSION: ADDRESSING THE PROBLEMS

My interpretation of Boyle allows us to see that the three 'problems' presented earlier are not genuine problems for him. To say that dispositive qualities can do the work of actual qualities in natural philosophy is to say something that Boyle explicitly rules out, namely a priori reasoning in natural philosophy. Think about how we could possibly say that a body is dispositively F, given Boyle's method. We could only attribute dispositively-F on the basis of the observation of the manifestation of actually-F. Thus, there is no a priori attribution of dispositive qualities. The attribution of a dispositive quality depends on the prior observation of a manifestation of an actual quality. Actual qualities, then, are indispensable for dispositive qualities, but dispositive qualities are dispensable for actual qualities (see W_6). Therefore, dispositive qualities cannot render actual qualities dispensable to natural philosophy. Moreover, according to Boyle, an actual quality is had only when ARR is satisfied. If actual qualities are required for dispositive qualities, then Boyle's theory of relative qualities is unaffected and the attack on the scholastics' *qualitates reales* can go forward. Finally, given the dependence of dispositive qualities on actual qualities, the corpuscularian philosophy, which entails the relative nature of qualities, is unaffected.

I have attempted to show that Boyle can allow attributions of dispositive qualities without damage to his theory of relative qualities. Boyle's method rejects a priori reasoning in natural philosophy, and an attribution of dispositive whiteness to snow or dispositive heat

to coal in the absence of observation of the manifestation of actual whiteness and actual heat would constitute the worst kind of a priori speculation a natural philosopher could embrace. Dispositive qualities are attributed only to kinds or members of kinds, and according to Boyle's theory of kinds, kinds cannot be formed without observation of the manifestation of actual qualities. I have also attempted to say something about *what* dispositive qualities are. Given that they cannot be anything *in re* other than mechanical affections, but that they are mechanical affections *known* to have behaved in certain ways, dispositive qualities are similar to *entia rationis* grounded in a body's mechanical affections. They are mechanical affections *considered* in a certain way. And the way they are considered depends on there being or having been actual qualities, and actual qualities have a relative nature—they must satisfy ARR. Therefore, Boyle's theory of relative qualities survives the admission of dispositive qualities.[77]

University of Colorado, Boulder

[77] An earlier and much shorter version of this chapter was given at the New England Colloquium in Early Modern Philosophy at Harvard. I wish to thank members of that audience, especially Justin Broackes, Don Garrett, Anja Jauernig, Martin Lin, and Alison Simmons, for their helpful comments. Thanks also to my colleagues Bob Pasnau and Rob Rupert, and to past students Andrew Alwood, Bryan Hall, and Derek Kern, for discussing the issues in this chapter with me. Thanks to the editors of *OSEMP*, Dan Garber and Steve Nadler, for their comments and suggestions. For miscellaneous help, I thank Michael Ben-Chaim and Jennifer McKitrick. Finally, thanks to Amy Weller and Sophie Charlotte Lovetron for creating an environment in which it was easy to devote so much time to Boyle.