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# James Jurin Awakens Hume from His Dogmatic Slumber. With a Short Tract on Visual Acuity

ROLF GEORGE

*Abstract*: After a discourse about the literature on visual acuity before Hume, I discuss how the “size” of visual objects is defined and determined. I shall then present circumstantial, but commanding, evidence for the influence of James Jurin’s *Essay upon Distinct and Indistinct Vision* on Hume’s thought. This work contains well-supported findings incompatible with claims made in T 1.2, “Of the ideas of space and time,” and elsewhere. Specifically, the prominent principle of the *Treatise*, “[w]hat consists of parts is distinguishable into them, and what is distinguishable is separable” (T 1.2.1.3; SBN 27) is shown to be false. A powerful principle, it is a premise to the most important arguments of the *Treatise*, but is shunned in the *Enquiry* and later writings because, I believe, Hume had read Jurin.

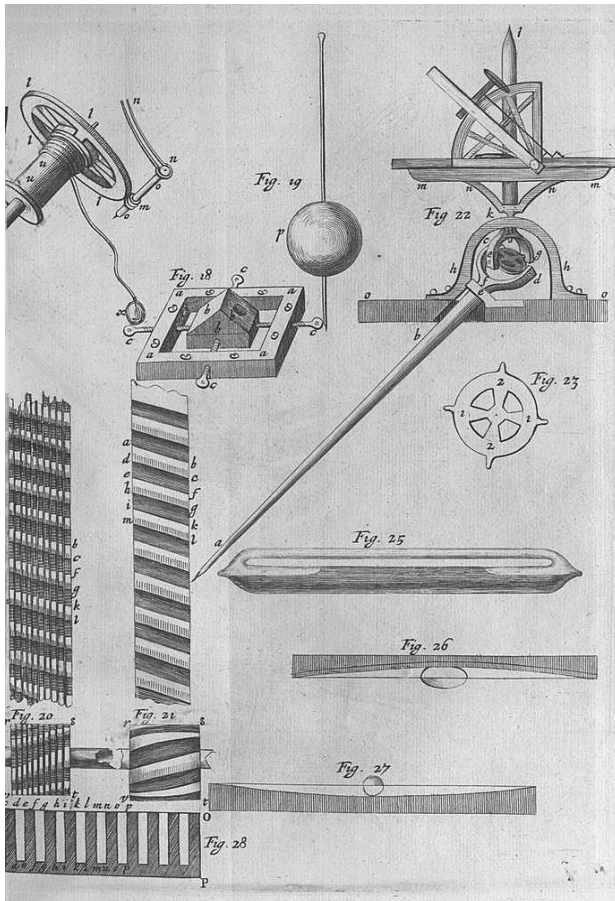
## 1. The Science of Vision before Hume

On March 2, 1693, William Molyneux wrote to John Locke:

You assert what I conceive is an error in fact, viz. “that a man’s eye can distinguish a second of a circle, whereof its self is the centre.” Whereas it is certain that few men’s eyes can distinguish less than 30 seconds, and most not under a minute, or 60 seconds, as is manifest from what Mr.

Hook lays down in his *Animadversions on the First Part of Hevelii Machina Coelestis*, p. 8, 9, &c. But this, as I said before, is only an error in fact and affects not the doctrine laid down in the said section.<sup>1</sup>

Hooke's *Animadversions* were aimed at Johannes Hevelius of Danzig who used open sights on angle-measuring instruments to determine celestial positions, and wrote in *Machina Coelestis* of 1673 that this technique was superior to the use of telescopes. Hooke, The Royal Society's curator of experiments, criticized Hevelius's method because, as he thought, it cannot distinguish an object or space between objects that subtends upon the eye an angle smaller than 30 seconds of arc, leading to major errors in the plotting of stars. To prove this he asked that a diagram of alternating black and white bars be drawn, an inch wide each. Figure 28 (lower left) of the diagram below, attached to the *Animadversions*, is not itself the distal object for the experiment, but is meant as a pattern for producing one, with black and white stripes one inch in width:



Let him expose this paper against a wall open to the light, and if it may be so that the sun shine upon it, and removing himself backwards for the space of 287  $\frac{1}{3}$  feet, let him try whether he can distinguish it, and number the dark and light spaces. And if his eyes be so good that he can, let him still go further backwards from the same, till he finds his eyes unable any longer to distinguish those Divisions.<sup>2</sup>

Even if perplexed by the mathematical precision imposed on an essentially imprecise measure, we can calculate that an object one inch in size will subtend an angle of exactly 30", or half a minute, at a distance of 287  $\frac{1}{3}$  feet. Locke consequently changed his text in the 1694 edition:

*The least portions of [duration or extension] whereof we have clear and distinct ideas, may perhaps be fittest to be considered by us, as the simple ideas of that kind out of which our complex modes of space, extension and duration are made up, and into which they can again be distinctly resolved. Such a small part in duration may be called a moment, and is the time of one idea in our minds, in the train of their ordinary succession there. The other, wanting a proper name, I know not whether I may be allowed to call a sensible point, meaning thereby the least particle of matter or space we can discern, which is ordinarily about a minute, and to the sharpest eyes seldom less than thirty seconds of a circle whereof the eye is the centre. (Essay, 2.15.9)*

While this *measure* of visual minima was generally accepted, Locke did not assign them the same status as Berkeley or Hume:

Could the mind . . . come to so small a part of extension or duration as excluded divisibility, that would be, as it were, the indivisible unit or idea; by repetition of which, it would make its more enlarged ideas of extension and duration. But . . . the mind is not able to frame an idea of *any* space without parts.

Every part of duration is duration too; and every part of extension is extension, both of them capable of addition or division *in infinitum*. (Essay, 2.15.9)

He claimed only that the least portions of space "*whereof we have clear and distinct ideas*" (Essay, 2.15.9) subtend an angle of about a minute.

Berkeley insisted against Locke that there are in fact indivisible *minima sensibilia* that "make up" extended visual or tactile objects. In the *New Theory of Vision*, he writes:

[Visible or tangible] magnitudes are greater or lesser, according as they contain in them more or fewer points, they being made up of points or minimums.<sup>3</sup>

In the same text he says that the moon is thirty visible points in diameter, which fixes the *minimum visibile* at about 1' (*Works*, 1:187), and in his *Philosophical Commentaries* he claims that the *punctum visibile* subtends 30".<sup>4</sup> We may safely assume that he, too, had consulted the authority of Hooke, who pronounced on the size of the *minimum visibile* not only in his *Animadversions* but also in lectures to the Royal Society, published posthumously in 1705:

The sensation of Man's Sight is limited to a certain bigness, less than which none can be distinguished; which, as I have elsewhere shewed, is not less than what is comprised within about a half a Minute of a Degree, at most, of the Orbicular Part of the bottom of the Eye; which in all probability is from the bigness of the smallest sensible Part receiving the Image, or of the Optick Nerve that is capable of conveying a distinct Motion of Sensation to the Brain, as *Des Cartes* has very ingeniously explained.<sup>5</sup>

Descartes had solved a conundrum that beset the astronomical community, as well as the theorists of vision, for several decades. A star observed through a telescope appears no larger than when seen with the naked eye. It was a major argument against Galileo, and indeed the Copernican system, that important findings were obtained with an absurd instrument that makes some things look larger, for example the gaps between stars, but others, the stars themselves, not.<sup>6</sup>

Galileo could not explain why stars appear no larger through a telescope than to the naked eye.<sup>7</sup> Descartes, as Hooke noted, solved the problem. While heavenly bodies subtend angles very much smaller than the minimum he had determined (Mars varies from 4" to 16" and Sirius, only recently measured, is a point of light  $\approx 0.007''$ ), they are not black spots on white paper, but intense daggers of light that agitate the nerves in the fund of the eye to generate an image. This image cannot be smaller than the *minimum visibile*, which is the smallest the visual system can manage. They are blown up, as it were. Descartes notes "that the stars, even though they appear quite small, nevertheless appear very much larger than their extreme distance should cause them to appear."<sup>8</sup> Hooke says,

[i]f the Telescope do not so far increase the real Diameter of the Object as to make it more than a Minute, it does seem indeed not at all to magnify it; because it is still made to appear, but under the [i.e., with an] Angle

of a Minute. Des Cartes has a very ingenious Explication. . . . The Fallacy lies in the Eye and not in the Instrument. For, as I said, such is the make of the sensible part of the Eye . . . that it cannot distinguish in most Eyes an Angle less than a Minute.<sup>9</sup>

The concept of visible minima and experiments connected with visual acuity were in the domain of common knowledge; the issues were much discussed and the texts so far quoted readily available. The *Dioptrics* of William and Samuel Molyneux state: "Tis manifest by Experiments, that the ordinary Power of Man's Eye extends no farther than perceiving what subtends an Angle of about a Minute, or something less."<sup>10</sup> I mention as well the earlier experiment of Marin Mersenne, who stated that a grain of sand could be seen from a distance of 10 or 12 feet. He estimated the diameter of the grain at one tenth of a "Paris line" (which is itself 1/12 of a "Paris inch") or 0.226 mm, and calculated the angular size at 15s of arc.<sup>11</sup> The motivation for this research among theorists of vision was to discover the structure of visual receptors. William Porterfield, an Edinburgh physician, restating Descartes's contention, wrote in 1738:

To shew how small Objects may become invisible to the naked eye, even when their Picture is distinct upon the Retina, it must be observed, that there is a *minimum visibile*, and that all objects, however small, if at all seen, are seen of that bigness. . . . The learned Dr. *Hook* by an easy Experiment found the *minimum visibile* in most Eyes to be comprehended within an Angle of one Minute.<sup>12</sup>

Hume showed some familiarity with the physiology of perception as then understood when he puzzled over the problem of how an object could seem larger or smaller in comparison with others:

When an object augments or diminishes to the eye or imagination, from a comparison with others, the image and idea of the object are still the same, and are equally extended in the *retina*, and in the brain or organ of perception. The eyes refract the rays of light, and the optic nerves convey the images to the brain in the very same manner, whether a great or small object has preceded; nor does even the imagination alter the dimensions of its object on account of a comparison with others. (T 2.2.8.3; SBN 372)<sup>13</sup>

I mention only in passing the problem here addressed, namely, that the apparent size of objects of vision depends not only on the angle they subtend upon the eye, but upon various other factors as well:

But as there is a certain degree of an emotion, which commonly attends every magnitude of an object; when the emotion increases, we naturally imagine that the object has likewise increas'd. (T 2.2.8.6; SBN 374)

Berkeley had earlier addressed this problem when he discussed, in the *New Theory of Vision*, the “celebrated phenomenon” that “the apparent magnitude of the moon when placed in the horizon is much greater than when it is in the meridian” (*Works*, 1:96), although the angle it subtends is actually smaller than that of the moon in zenith.

Hume, like other schoolboys of a seafaring nation, would have learned the visual size of prominent objects early in life: sun and moon subtend 30'; the thumbnail of an outstretched hand is about two degrees (some think that *this* is the “rule of thumb”), and so forth. He would have expressed the size of visual points in the same terms as Galileo, Descartes, Mersenne, Locke, Berkeley, Molyneux, Porterfield, and others, if asked, and probably would have assigned the same magnitude to them. He describes in a well-known passage a procedure like Hooke’s for creating a visual minimum:

Put a spot of ink upon paper, fix your eye upon that spot, and retire to such a distance that at last you lose sight of it; it is plain, that the moment before it vanished, the image, or impression, was perfectly indivisible. It is not for want of rays of light striking on our eyes, that the minute parts of distant bodies convey not any sensible impression; but because they are removed beyond that distance, at which their impressions were reduced to a minimum, and were incapable of any further diminution. (T 1.2.1.4; SBN 27)

The minimum, the spot just before it disappears, is called “perfectly indivisible,” “incapable of any farther diminution.” We may also assume that Hume had read Locke’s account of the smallest object that can be distinctly seen.<sup>14</sup> And, as is well known, he agreed with Berkeley in maintaining that our ideas of time, space and extended things in general are “compounded of parts, which are indivisible” (T 1.2.3.12; SBN 38).

## 2. Indivisibles and Extension

Part 2 of the first Book of the *Treatise*, “Of the ideas of space and time,” has had a bad press. Flew says that “by common consent” it is its least satisfactory part, “perhaps the least satisfactory in all Hume’s publications.”<sup>15</sup> Earlier judgements were harsher. C. D. Broad writes:

There seems to be nothing whatever in Hume's doctrine of Space excepting a great deal of ingenuity wasted in recommending and defending palpable nonsense.<sup>16</sup>

According to Prichard,

There is a great deal of cleverness in it, but the cleverness is only that of extreme ingenuity and perversity, and the ingenuity is only exceeded by the perversity.<sup>17</sup>

Recent discussions have been more sympathetic, crediting Hume with a keen understanding of the problems, sometimes called the labyrinth, of the composition of the continuum.<sup>18</sup> Hume's theory of visible or tangible points was meant to resolve the issue by stipulating, as Berkeley had earlier, that there are visual and tactile minima. Hume repeatedly calls them "indivisible," "minute," "without parts," and so forth, but never "extensionless," "without extension," or "unextended." Yet almost all recent commentary assumes that Hume meant to claim just this, that he meant his points to be coloured, or solid to the touch, but without extension, and that extension results only from their accumulation.

H. Mark Pressman says: "Hume maintains that visible points are not extended,"<sup>19</sup> and supports his claim with the following passage:

Every idea, that is distinguishable, being also separable, let us take one of those simple, indivisible ideas, of which the compound one of extension is form'd . . . 'Tis plain it is not the idea of extension, for the idea of extension consists of parts, and this idea, according to the supposition is perfectly simple and indivisible. Is it therefore nothing? That is absolutely impossible. (T 1.2.3.13–14; SBN 38)

This points to an ambiguity in "extension," "extended," and "unextended": being unextended could mean having no size (angular extension) whatsoever, in the sense of subtending an angle of 0° upon the eye. But at Hume's time, an object was called extended if it has contiguous spatial parts, and unextended if it does not. Most modern commentators, though they do not usually discuss the issue with the precision it deserves, accept the former as Hume's view, often with misgivings.

However, this was not the common and accepted definition at all. Rather, to be extended meant being *composite, having parts*. Consider an early review of the *Treatise in Common Sense: Or the Englishman's Journal* of July 5, 1740. In the course of his argument against Hume and in support of infinite divisibility, the anonymous author says,

if I remember any Thing of the old Philosophy I learned at School, the definition of *Extension* was, *Quod habet partes extra partes*.<sup>20</sup>

This was, in fact, common usage. Here is Descartes: “I call extended only what is imaginable as having *partes extra partes*.”<sup>21</sup> Leibniz, in a letter to Des Bosses writes, “The extension of bodies seems to be nothing other than the contiguity of its parts—*partes extra partes*.”<sup>22</sup> Locke says that it is “altogether as intelligible to say that a body is extended without parts, as that anything thinks without being conscious of it” (*Essay*, 2.1.19), and that it is *usual* to say that being extended is to have *partes extra partes* (*Essay*, 2.13.15). He defines it as a “continuity of parts.”<sup>23</sup> In Ephraim Chambers’ *Cyclopaedia* we find, “[e]xtension is usually described, as consisting, *in the situation of Parts, beyond Parts*.”<sup>24</sup> Hooke had shown that a visual minimum subtends a measurable angle upon the eye, but he did not call it extended, since, “[e]xtension cannot well be conceived without Body. . . . Wherever there is Extension, there really is a Body extended.”<sup>25</sup>

To say of the visual minimum that it is without extension cannot mean that it subtends an angle of zero degrees. Rather, the concept of extension does not apply to the optical magnitude of visual minima since they have no parts and, by definition, nothing is extended unless it has parts. In the above quotation Hume makes this very point: the visible minimum is not the idea of extension since, being indivisible, it has no parts, whereas, “[t]he idea of extension consists of parts.” Extension is constructed by repeating and adding minima:

I first take the least idea I can form of a part of extension . . . I then repeat this idea once, twice, thrice, etc., and find the compound idea of extension, arising from its repetition, always to augment, and become double, triple, quadruple, etc., till at last it swells up to a considerable bulk, greater or smaller, in proportion as I repeat more or less the same idea. (T 1.2.2.2; SBN 29)

Elsewhere he says that *separability* and mobility are “distinguishing properties of extended objects” (T 1.4.5.15; SBN 239).

Also, the minimal size of the ink spot after one has retreated from it is easily triangulated. Hume implied that the minimum can be measured when he said that for *time* there is “no exact method of determining the proportions of parts, not even so exact as in extension” (T 1.2.4.24; SBN 48). Evidently, then, the smallest parts of extension *can* be measured using methods like those of Hooke, though without his specious precision. They are “lesser impressions, that are indivisible to the eye or feeling, and may be call’d impressions of atoms or corpuscles endow’d with colour and solidity” (T 1.2.3.15; SBN 38). They have a “degree of minuteness”

that cannot be reduced (T 1.2.2.5; SBN 31) and cannot be “diminish’d without total annihilation” (T 1.2.1.3; SBN 27).<sup>26</sup>

I shall therefore maintain that Hume never meant to say that the “simple, indivisible ideas” are unextended “sense data” in the sense of subtending an angle of 0°, especially since he and his contemporaries never used the term “extension” to describe the angular size of a visual image.

But if visual points do subtend a finite angle upon the eye, perhaps the usual 30", it would seem that they have edges, sides, parts that can be distinguished. But this argument turns on the kind of mathematical thinking Hume endeavoured to denounce. The question is not if, in some abstract sense, minima have parts, but whether they have *visible* parts. Consider the very first review of the *Treatise*, by an anonymous author, which appeared at the end of 1739 in the *History of the Works of the Learned*. Hume found the review, which is perceptive but sarcastic, “somewhat abusive.”<sup>27</sup> The reviewer quotes the *separability principle*, that whatever is distinct is separable, from the following *Treatise* passage:

What consists of parts is distinguishable into them, and what is distinguishable is separable. But, whatever we may imagine of the thing, the idea of a grain of sand is not distinguishable nor separable into twenty, much less into a thousand, ten thousand, or an infinite number of different ideas. (T 1.2.1.3; SBN 27)

To this he affixes the following note:

This axiom is somewhat like a conjurer’s *hocus-pocus*; it works wonders, and is at every turn repeated. Let this gentleman apply it once more in the case before us; let him try if he can conceive in his imagination a grain of sand, without conceiving a surface; and let him try if he can imagine any surface without at least two distinguishable, and consequently, according to his own axiom, separable sides.<sup>28</sup>

I shall presently return to separability, but want to deal first with the problem of the distinguishable sides of the grain.

I suggest that readers draw a thin black straight line on white paper, expose it to light, and back away from it as instructed by Hooke, Hume, and others. They will notice that this line has visible length with distinguishable parts, but no visible width, no separable edges even if the width subtends a measurable angle upon the eye. With a spot or a grain of sand the experiment is a little more difficult, but can still be carried out with the same effect, which had already been observed by Marin Mersenne. Edges cannot be *seen* as separate if the angle that separates them is small enough.

Lorne Falkenstein commented as follows on an earlier version of this paper:

If a minimum visible has a size of 30 seconds of arc then the place of its left edge is removed from the place of the right edge by a distance of 30 seconds of arc. But if the left edge and the right edge are separated by a distance, then the minimum must have distinct left and right sides and so must be further divisible. The best way to avoid the conclusion of this argument is to maintain that the left side of a minimum visible is not in a visibly different place from the right side, which is tantamount to holding that it has zero angular magnitude.<sup>29</sup>

Angular separation and *visible* distinction are not the same. It is an empirical question how much separation is required before two stimuli are seen in distinct places, and the findings do not support Falkenstein's conclusion. The so-called *minimum resolvable*, seeing two stimuli as separate, is not as small as the *minimum visible*. For normal sight the smallest visible black dot on white paper subtends 10"–35", the separation required for seeing two stimuli as separate is 30"–60". Hence it is possible to see a grain of sand without seeing distinct sides.

Since visual points subtend a small angle, two of them can touch and form a larger object, as extensionless points could not. Hume responds to a common argument that two points adjoined cannot create a larger object, by correctly pointing out that *his* minima can very well be assembled into larger objects:

From the union of these points there results an object, which is compounded and divisible and may be distinguish'd into two parts, of which each preserves its existence distinct and separate, notwithstanding its contiguity with the other. (T 1.2.4.6; SBN 41)

### 3. The Separability Principle

As the abusive reviewer noted, the just cited principle, "what consists of parts is distinguishable into them, and what is distinguishable is separable," and its converse are wielded often and with striking results in the *Treatise*. Don Garrett points out, correctly, that,

unlike the Copy Principle,<sup>30</sup> which has an acknowledged antecedent in Locke's denial of innate ideas, Hume's Separability Principle—the second of his two fundamental principles—has no obvious predecessors.<sup>31</sup>

This is not to deny that earlier philosophers argued that certain compound ideas pointed to separable items, or discussed the conditions under which separate ideas betokened separate substances. Descartes claims that whatever substances can be clearly and distinctly understood as existing apart can be separated from each other. This move from distinct ideas of substances to separability is underwritten by God's omnipotence. Thus, in the *Sixth Meditation*, he reasons that he has a clear and distinct understanding of himself as a thinking thing and a clear and distinct idea of body. Because he can think the two as existing apart, he concludes that he is separable from his body. To claim otherwise would entail a denial of divine power, since God can create things corresponding to clear and distinct ideas. In the same *Meditation*, however, and more explicitly in his *Replies to the First Set of Objections* and his *Principles of Philosophy*,<sup>32</sup> Descartes denies, like Suarez before him, that the shape or motion of a thing could exist in the absence of the thing itself, even if they are distinct from it. In short, therefore, Descartes considers explicitly whether any two distinct things are separable from each other, accepts this claim in the special case of substances and draws an important conclusion from it about mind and body; but he rejects the Separability Principle as a general rule.

By contrast, unlike all earlier philosophers who had given thought to the problems of separation,<sup>33</sup> Hume advanced the principle in complete generality and noted that it is "equally true in the *inverse*" (T 1.1.7.3; SBN 18). He thought of it as an *individual, single* axiom, and not a shorthand or summing up of several principles. It follows that if any consequence, any instance, any application of it is shown to be false, the principle itself is disproved. This will be discussed later. First a few comments on the principle and its employment.

The separability principle conflicts with what was called a *distinction of reason*. For example, Arnauld and Nicole state in the *Port Royal Logic* that a distinction of reason is made "when, in the case of a single thing having different attributes, we think of one attribute without thinking of the other."<sup>34</sup> Against this, Hume notes:

The difficulty of explaining this distinction arises from the principle above-explained, *that all ideas, which are different, are separable*. For it follows from thence, that if the figure be different from the body, their ideas must be separable as well as distinguishable. (T 1.1.7.17; SBN 24)

This, Hume thinks, cannot be. David and Mary Norton comment:

But as we cannot so separate body and figure (and many other pairs of ideas), it appears that either the [separability] principle is false, or that we need to reconsider the nature of distinctions of reason. Hume chooses the latter option. (T 434)

We should note that the *inverse* is used more often than the principle itself. The separate existence of a substantial soul is denied on the grounds that when entering “most intimately” into himself he finds nothing distinguishable and separable from particular perceptions; hence, “[t]here is properly no *simplicity* in it at one time, nor *identity* in different” (T 1.4.6.3–4; SBN 252–53). The different perceptions are distinct and different and cannot be run together to make a unit (T 1.4.6.16; SBN 259–60). It is also used to argue against an abstract idea of existence: “We have no abstract idea of existence distinguishable and separable from the idea of particular objects” (T 1.2.6.4, App. 2; SBN 66–67, 624–25), whence Kant probably got the notion that existence is not a predicate. The following cannot be distinguished and hence not separated—figure from body figured (T 1.1.7.17; SBN 24–25), time from “our successive perceptions”—(and is therefore not a “primary distinct impression” (T 1.2.3.10; SBN 36–37)), nor can we distinguish substance from our perceptions (T 1.4.5.5; SBN 233).

In each case the argument proceeds from the impossibility of distinguishing, and hence separating ideas, to the denial of some accepted theory. For example, we have no idea of *time* separate from successive impressions, and in fact can only *imagine* a stretch of time by imagining successive events, as in a melody:

The idea of time is not derived from a particular impression mixed up with others, and plainly distinguishable from them, but arises altogether from the manner in which impressions appear to the mind, without making one of the number. Five notes played on a flute give us the impression and idea of time, though time be not a sixth impression which presents itself to the hearing or any other of the senses. (T 1.2.3.10; SBN 36)

Hume maintained, quite generally, that by consulting the imagination, we can determine what ideas are *not* separable: the imagination is the chief weapon wherever the *inverse* of the separability principle is at issue.

The principle itself, rather than the inverse, is employed to establish Hume’s view on causation (for example, T 1.3.3.3; SBN 79), including the problem of the will as a cause of action (T 1.3.14.12; SBN 632–33), and on the perception of extended visual and tactile objects.

The language employed on this second topic suggests that here it will often not be enough to consult one’s ideas and imagination, a method very satisfactory when the inverse is at issue. We just noted that we can determine the optical size of minima, that they can be moved about and made to conjoin, that we back away from a spot on paper to establish a minimum, and so forth. How should we understand Hume when he asks us to “separate” a simple indivisible idea from all others (T 1.2.3.13; SBN 38)? I can only give this a realist reading. As is common in experiments in vision, or in the office of an optometrist, we manipulate the

“phenomenal” object by changing the “distal” object, or target. I do not believe that Hume meant us to “separate” a point from a line simply by concentrating or fixing on it, or *merely imagining* it separated from the rest.

I ask any one if he sees a necessity that a coloured or tangible point should be annihilated upon the approach of another coloured or tangible point? On the contrary, does he not evidently perceive, that, from the union of these points, there results an object which is compounded and divisible, and may be distinguished into two parts. (T 1.2.4.6; SBN 41)

Bringing about the union of two points is to adjoin two dots to create the compound object. Hume does not suggest here that we should look at two separate points and then “imagine” them to move together and touch. Further, given a certain space, an extension, or perhaps just a line, we can distinguish and separate a visual point, cut it off, detach it from the rest. The point, being distinguishable, must be separable. I do not believe that Hume would have objected to experimental apparatus, such as the device suggested in Chambers’s *Cyclopaedia*, viz. “a little hole in a thin plate”<sup>35</sup> through which one examines the parts of a line. As well, it follows that, if we see a certain length of line, we can not only split off points, but can also divide it in half or other fractions down to the size of the visual minimum. So if a line of a certain length is perceptible, and its halves or thirds or other fractions are distinguishable, then they must also be separable, that is, individually visible. It must be possible to see them by themselves, separate from each other. This, it turns out, is a mistake.

#### 4. James Jurin’s Experiments

Shortly after the publication of the *Treatise* in 1739, Hume returned to his home at Ninewells, and often visited Edinburgh. There he will have seen and discussed Robert Smith’s *Opticks*, recently published. Comprehensive and reliable, the book became the most influential optical treatise of the eighteenth century and was translated into Dutch, German, and French.<sup>36</sup> It contained as an appendix *An Essay Upon Distinct and Indistinct Vision* by James Jurin, a pioneer work in physiological optics.<sup>37</sup>

Several Edinburgh notables were subscribers to Smith’s work, among them Walter Goodall for the Advocates Library, where Hume later became the Librarian, several professors of the university, members of the Rankenian Club (Hume had been a member when he was a student), Hume’s friend Andrew Mitchell, the Edinburgh Philosophical Library and the Edinburgh University Library. As well, Jurin’s essay was reviewed favourably and in great detail in the April, 1740, edition of the *History of the Works of the Learned*, only three months after the abusive review of the *Treatise*.<sup>38</sup> Jurin’s work surely came to Hume’s attention.

Jurin (1684–1750) had been a student of Newton’s, a member of the Royal Society and their Secretary from 1721 until Newton’s death in 1727. This was one of the most influential positions in the intellectual world; one of his duties was to solicit and select the contributions to the *Philosophical Transactions*. He was a well-known physician and scientist, advocate of smallpox inoculation, and initiator of medical statistics, which he used to prove the efficacy of this method in controlling the disease. In the year of his death he was elected president of the Royal College of Physicians. It testifies to his prominence that he was called upon to treat the prime minister, Robert Walpole, for the stone. Unfortunately he dispatched Walpole with one of his elixirs. Jurin, the kind of person now called a “public intellectual,” was in the thick of the intellectual life of the period. He commanded attention.

Among other things he was known for his contretemps with Berkeley and his response to Berkeley’s *Analyst*<sup>39</sup> in *Geometry no Friend to Infidelity; or a Defence of Sir Isaac Newton and the British Mathematicians*.<sup>40</sup> Benjamin Robins, another defender of Newton against Berkeley, later opposed him over the exact interpretation of the theory of fluxions, a dispute that went on for several years and is well known to historians of mathematics.<sup>41</sup> To give a taste of the style of debate then common, here is an excerpt from one of Robins’s contributions:

Thus has this learned Gentleman unhappily attempted the application and improvement of a doctrine, of which, it appears, he was not qualified do describe even the very rudiments.<sup>42</sup>

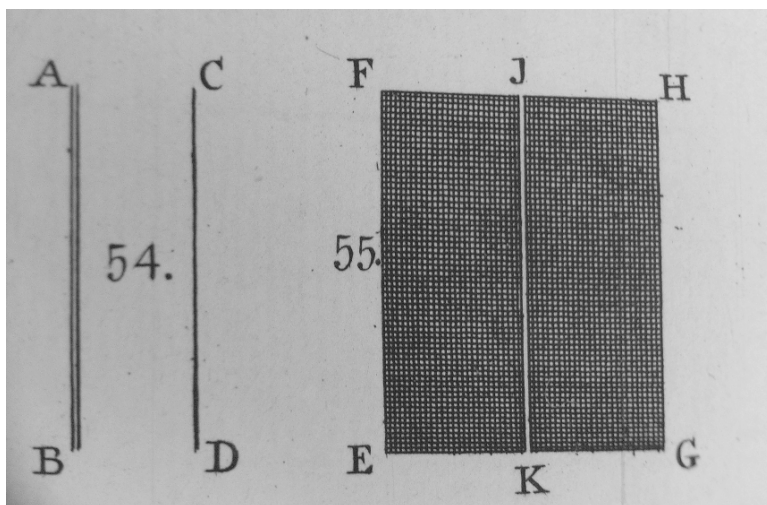
Being a much better hand at medical statistics, Jurin later pounced on Berkeley in *A letter to the Right Reverend the Bishop of Cloyne, occasion’d by His Lordship’s Treatise on the virtues of tar-water. Impartially examining how far that medicine deserves the character His Lordship has given of it*.<sup>43</sup> Berkeley responded in verse:

To drink or not to drink! that is the doubt,  
With *pro* and *con* the learn’d would make it out.  
*Britons, drink on!* the jolly prelate cries:  
What the prelate persuades the doctor denies.  
But why need the parties so learnedly fight,  
Or choleric Jurin so fiercely indite?  
Sure our senses can tell if the liquor be right.  
What agrees with his stomach, and what with his head,  
The drinker may feel, though he can’t write or read.  
Then authority’s nothing: the doctors are men:  
And *who drinks tar-water will drink it again.* (*Works*, 5:225)

Jurin was the first to distinguish the minimum visible (the smallest visible dot on a contrasting background) from the minimum resolvable (seeing two stimuli as separate). He noted that “there are other cases [than a black dot upon a white ground] in which a much less angle [than the usual 30 seconds] can be discerned by the eye,” to wit, the stars (*Essay*, 148). But most importantly for our topic, he found that “a line, of the same breadth with a circular spot, will be visible at such a distance as the spot is not” (*Essay*, 148). The effect is undeniable and can easily be repeated in one’s study. This result has important implications for Hume’s (and Berkeley’s) finitist construction of geometry. Jurin conducted a variety of further experiments in physiological optics: a white line on a black background has the same properties as a black one against a white background. I note, in passing, another intriguing discovery:

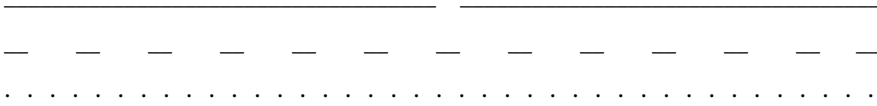
It might naturally be expected, that a white space between two black parallel lines, the space being of the same breadth as each of the lines, should also be visible within those limits, when the space subtends an angle of only 2 or 3 seconds, or that this space should be visible as one of the lines singly taken is perceivable. . . . But the case is far otherwise. (*Essay*, 150)

In figures 54 and 55 Jurin shows that the space between the double lines AB will be imperceptible at a certain distance when the single line CD, and the white line JK against the black background in figure 55, can still be seen (Segment of Plate 19 at the end of Jurin’s *Essay*). This establishes that the *context* in which a visual object is presented will influence its visual properties—a result at odds with Hume’s analysis of visual perception.



More importantly, it is not consistent with Hume’s or Berkeley’s theory of minima that a line whose width subtends an angle of only three seconds should be visible to the naked eye at all, while a spot of the same size is not.<sup>44</sup> This has far-reaching

consequences for the separability principle, the *hocus pocus* of the *Treatise*. Jurin’s experiments show the principle to be false. If a line has a width of only three seconds, it cannot be broken up into Humean minima. It has some parts that can be *distinguished*, but not *separated*; we cannot have *separate impressions* of these parts. I invite readers to draw, with a thin black stylus, some appropriate lines and rows of dots on white paper like these:



They will find that when seen in a bright light, longer lines can be seen from farther away than shorter ones or points. If they experiment diligently, they will be able to determine the length of the shortest line whose halves they cannot perceive. Since all divisions other than halving will create even shorter segments, no division of such a line will produce two visible segments. But Hume’s understanding of geometry in the *Treatise*—as also Berkeley’s—absolutely depends on the assumption that the magnitude of an extended object, a line for instance, is a function of the number of distinctly visible minimal points that “compose” it:

Lines or surfaces are equal, when the numbers of points in each are equal, and that as the proportion of the numbers varies, the proportion of the lines and surfaces is also vary’d. (T 1.2.4.18; SBN 45)

Two lines are equal when the numbers of the points, that compose them, are equal, and when there is a point in one corresponding to a point in the other. (T Abstract 29; SBN 658)

The size of geometrical objects is proportional to the number of points in them, even if we cannot simply count them, since they are “so minute and confounded with each other, that ’tis utterly impossible for the mind to compute their number” (T 1.2.4.19; SBN 45). Note that if the confounding makes counting impossible, then the parts cannot really be distinguished and separated “by the imagination,” contrary to Hume’s contention elsewhere:

A real extension . . . can never exist without parts different from each other; and wherever objects are different, they are distinguishable and separable by the imagination. (T 1.2.4.3; SBN 40)

When *minima visibilia* touch and form a line, it will be 30" to one minute wide, that is, rather fat. Jurin’s experiments show that the converse does not

hold: a visual line need not be an assemblage of 30" visual points. There are yet other problems. Surfaces, claimed to be equal if the number of *points* in them are equal, can also be construed as assemblies of lines.<sup>45</sup> To constitute a given surface it takes about ten times as many of Jurin's thin lines as of lines assembled of points.<sup>46</sup>

I have no doubt that Hume knew of Jurin's work, but the evidence is circumstantial. Yet it is a reasonable conjecture that Jurin's essay changed his mind on the nature of geometry and the validity of the separability principle—something did, and nothing else has been suggested or discovered.

In the *Treatise*, Hume said:

[G]eometry falls short of that perfect precision and certainty, which are peculiar to arithmetic and algebra. . . . The reason why I impute any defect to geometry, is, because its original and fundamental principles are derived merely from appearances; and it may perhaps be imagined, that this defect must always attend it, and keep it from ever reaching a greater exactness in the comparison of objects or ideas, than what our eye or imagination alone is able to attain. (T 1.3.1.6; SBN 71)

Jurin's results would indeed force a very odd form of geometry, with thick lines that divide down to minimal points, and thin lines that do not. Further, if a line of a certain length cannot be divided without a segment disappearing from view, then it has "parts" that can be discerned, but are not visible by themselves. Is the shortest perceptible line itself then a minimum?

In the first *Enquiry* geometry has acquired a profoundly different status, now at par in precision to algebra and arithmetic:

All the objects of human reason or enquiry may naturally be divided into two kinds, to wit, *Relations of Ideas*, and *Matters of Fact*. Of the first kind are the sciences of Geometry, Algebra and Arithmetic; and in short, every affirmation, which is either intuitively or demonstratively certain. (EHU 4.1; SBN 25)

Even more important is that Hume jettisoned the separability principle. It is last mentioned, repeating a point made at T note 5 (SBN 637), in the already mentioned letter to Hutcheson in which he complained about the "abusive" reviewer:

The Word, *simple Idea*, is an abstract Term comprehending different Individuals that are similar. Yet the point of their Similarity from the very Nature of such Ideas is not distinct nor separable from the rest. (*Letters*, 1:36)

After this the principle is found no more, and new arguments are required on causation and other topics.

I noted above that the separability principle, like an axiom in a deductive system, is disproved if any consequence, any instance, any application is shown to be false. The difficulties are of particular concern if they arise within theories of space and time. In the first *Enquiry* Hume identifies “abstract reasonings” about space and time in the “profounder sciences” as the very source of the contradictions and absurdities that give purchase to the type of skepticism that is “consequent to science and inquiry” (EHU 12.17ff.; SBN 155ff.). It is therefore of especial importance carefully to investigate the ideas of space and time. I conjecture that Jurin’s work gave Hume a more adequate understanding and many second thoughts about these ideas, and that this is why he abandoned the separability principle.

## 5. Epilogue, or the Power of the Meta-Narrative

We have Kant’s word that his philosophical orientation underwent profound changes—from dogmatic to skeptical to critical and that Hume played a role by awakening him from his “dogmatic slumber.” Hume, by contrast, insisted that the *Enquiries* differed from his youthful *Treatise* only in emphasis and style, but not in fundamental doctrine.<sup>47</sup> Humeans and Kantians have tended to adopt their masters’ autobiographical constructions.

A.J. Ayer writes in his “Past Masters” introduction to Hume that “The *Enquiry* is . . . a much better written work than the *Treatise*, from which it differs more in emphasis than in argument.”<sup>48</sup> Of all people, Ayer—whose *Language, Truth and Logic*<sup>49</sup> had claimed that all of mathematics is “analytic” and empirical science “synthetic”—should have noticed the vast difference between *Treatise* and *Enquiry* on the subject of geometry. By putting a suitable gloss on Hume’s “relations of ideas,” the latter can be argued to place mathematics on the analytic side, where Ayer thought it belonged, while the view expounded in the *Treatise* is off the map.

More recently this issue has been revisited, and the break between the two works noted. Peter Millican states:

[I]t is very noteworthy that in the *Enquiry*: (a) the Separability Principle makes no appearance; (b) there is no explicit discussion of the simple-complex distinction which is arguably the Separability Principle’s foundation (Garrett 68); and (c) . . . , there is no developed theory of the structure of space and time, which in the *Treatise* is not only crucially based on the Separability Principle but also plays an important role in facilitating the simple-complex distinction by providing ultimate simples. (Garrett 74)<sup>50</sup>

I believe that, nudged by Jurin's findings, Hume gave up separability as an unjustified a priori principle, close to his heart, but an invention for which he had no evidence.<sup>51</sup> After being endorsed "at every turn" in the *Treatise*, it does not recur in the *Enquiry*. Most of the topics to which it was applied in the earlier work, for example, substance and personal identity, are not discussed at all. Of all the topics to which it was applied in the *Treatise* only causation and the influence of the will upon action recurs. But the style of argument is not the same. In the *Treatise*, Hume says:

All distinct ideas are separable from each other, and as the ideas of cause and effect are evidently distinct, 'twill be easy for us to conceive any object to be non-existent this moment, and existent the next, without conjoining to it the distinct idea of a cause or productive principle. (T 1.3.3.3; SBN 79)

[A]s all distinct ideas are separable, 'tis evident there can be no impossibility [of conceiving a causal sequence different from one observed]. When we pass from a present impression to the idea of any object, we might possibly have separated the idea from the impression, and have substituted any other idea in its room. (T 1.3.6.1; SBN 87)

In these passages Hume *deduces* the separability of cause and effect from his principle: the mind shows cause and effect distinct and hence separable, whereas in the *Enquiry* the mind does *not* show cause and effect to be *inseparable*: the difference is between *proving that something is the case*, and *failing to prove that it is not the case*:

When we reason *a priori*, and consider merely any object or cause, as it appears to the mind, independent of all observation, it never could suggest to us the notion of any distinct object, such as its effect, much less, show us the inseparable and inviolable connection between them. (EHU 4.13; SBN 31)

All events seem entirely loose and separate. One event follows another; but we never can observe any tie between them. They seem *conjoined*, but never *connected*. (EHU 7.26; SBN 74)<sup>52</sup>

This is not just a change in the manner of exposition, with the brashness of youth replaced by greater caution, but a change in substance.

This essay is meant to show not only that Hume changed his mind on separability, but that Jurin's *empirical* enquiry may very well have induced this change in Hume's *philosophical* convictions, a result that should be attractive to all Humeans. It is plausible to add Jurin to the widening list of authors whose influence on Hume can be documented or conjectured.<sup>53</sup>

I end on a cautionary note. It has been pointed out that if Hume was influenced by Jurin, one might expect him to yield on minima as well as on separability. Hume's minimalism must be wrong. But in the *Enquiry*, Hume wrote:

Whatever disputes there may be about mathematical points, we must allow that there are physical points, that is, parts of extension, which cannot be divided or lessened, either by the eye or imagination. These images, then, which are present to the fancy or the senses are absolutely indivisible, and consequently must be allowed by mathematicians to be infinitely less than any real part of extension; and yet nothing appears more certain to reason, than that an infinite number of them composes an infinite extension. (EHU 12.18n; SBN 156)<sup>54</sup>

I proffer two comments. First, Jurin's findings do not challenge the existence of visual minima, or the possibility of collecting them into larger objects, nor would he deny that these collections become larger if more minima are assembled. What is denied, however, is that *all* objects of geometry are collections of such minima. Second, the sentence just quoted occurs in the section 12, *Of the Academical or Sceptical Philosophy*, and is the antithesis to a claim, among others, that the demonstration of the principles of geometry (and the calculus, one of Jurin's specialties, as Hume knew) "seems as unexceptionable as that which proves the three angles of a triangle to be equal to two right ones" (EHU 12.18; SBN 157). The tension between the two claims and others like them is to lead us to a more *mitigated* skepticism, or ACADEMICAL philosophy (EHU 12.24; SBN 161). Conjointly, they betoken reservation more than conviction.

## NOTES

I thank Lorne Falkenstein, Don Baxter, David Raynor, Paul Rusnock, David and Mary Norton, Kenneth Westphal, and two anonymous, very perceptive reviewers from *Hume Studies*. They all provided generous comments on earlier versions of this essay. I am most indebted to Glen Koehn for letting me cite from his essay entitled "Hume Abandons the Separability Principle," which was read at the 2005 meeting of the Western Canadian Philosophical Association. The discussion of separability in Descartes, Suarez, Porphyry, and Aristotle is his work. I also owe much to the illuminating survey of acuity tests from Descartes and Mersenne to Helmholtz and beyond in Nicholas J. Wade, "Visual Neuroscience before the Neuron," *Perception* 33.7 (2004): 869-89.

Thanks reaching far into the past are due also to the people at the vision lab at Michigan State University: Thomas M. Nelson and S. Howard Bartley. I came to the study

of philosophy only after earlier work in physiological optics and the history of the science of vision. This work convinced me that real examples tend to be much more detailed and interesting than those made up by philosophers. I describe some of them in this essay.

1 In *Some Familiar Letters between Mr. Locke and Several of his Friends* (London, 1708), 32–38. Reprinted as letter 1609 in *The Correspondence of John Locke*, 8 vols. (Oxford: Clarendon Press, 1976–89), 4:650. Molyneux refers to John Locke's *Essay* 2.15.9, i.e., *An Essay Concerning Human Understanding*, ed. Alexander Graham Fraser, 2 vols. (New York: Dover, 1959), 1:267.

2 Robert Hooke, *Animadversions on the First part of the Machina coelestis of the Honourable, Learned, and Deservedly Famous Astronomer Johannes Hevelius, Consul of Dantzick, together with an Explication of some Instruments* (London: Printed by T.R. for J. Martyn, 1674), 9. Mentioned in the *Philosophical Transactions of the Royal Society* 9 (1674): 215–16. The illustrations are not themselves the intended distal objects of the experiment, but instructions for creating them.

3 George Berkeley, *An Essay towards a New Theory of Vision*, sect. 54, in *The Works of George Berkeley*, ed. A. A. Luce and T. E. Jessop, 9 vols. (London: Thomas Nelson, 1948–57), 1:191.

4 Berkeley, *Philosophical Commentaries*, No. 175, in Luce and Jessop, *Works of George Berkeley*, 1:24.

5 Robert Hooke, *Posthumous Works, Containing his Cutlerian Lectures, and other Discourses, Read at the Meetings of the Illustrious Royal Society* (London, 1705). Reproduced with a new introduction by Richard S. Westfall (New York: Johnson, 1969), 135.

6 In 1619 Lothario Sarsi claimed, “The telescope carries spectres to the eyes and deludes the mind with various images; therefore it does not display genuinely and without deception even those things which we observe close at hand, much less those which are far removed from us, except it will show them bewitched and deformed.” Sarsi, *The Astronomical and Philosophical Balance* (Perugia, 1619). Translated by Stillman Drake and C. D. O’Malley in *The Controversy of the Comets* (Philadelphia: University of Pennsylvania Press, 1960), 80. This prompted Sarsi to place the heliocentric theory in doubt, since Galileo had made extensive use of the telescope to support it. Sarsi is a pseudonym for Horatio Grassi, who reported, but did not personally share, this view. He opposed Galileo on other grounds, claiming among other things (as a “law” of optics) that a telescope enlarges less and less the farther away the target is removed. Galileo rightly deemed this theory “utterly false” (*The Assayer*, in *The Controversy on the Comets*, 151–336, 222) and answered in a lengthy polemic. If it were true, then an object very far away would indeed not be enlarged much, or at all. But also, if this law held, then the distance of any object could be ascertained with a telescope from a single point, without triangulation, “an admirable invention, which many others have attempted, but no one has ever achieved” (216).

7 He did note, what is commonplace in these discussions, that “the apparent magnitude of visible objects may be correctly determined by the size of the angles under which they are represented to us.” *The Assayer*, 221n4.

8 René Descartes, *Optics*, end of the Sixth Discourse “On Vision.” Quoted from *Discourse on Method, Optics, Geometry, and Meteorology*, ed. and trans. Paul J. Olscamp (Indianapolis: Hackett, 2001), 112.

9 Hooke, *Posthumous Works*, 98.

10 William and Samuel Molyneux, *Dioptrica Nova* (London: Benjamin Tooke, 1692 and 1709), 243. The work was dedicated to the Royal Society and was widely available.

11 This information is found in Wade, “Visual Neuroscience.” Mersenne’s *L’Optique et la Catoptrique* was published posthumously in 1651 (Paris: Langlois).

12 William Porterfield, “An Essay Concerning the motion of our Eyes,” *Edinburgh Medical Essays and Observations* 4 (1738): 124–294, 248–49. Quoted in Wade, “Visual Neuroscience,” 875.

13 The works of Hume are cited as follows: “T” is *A Treatise of Human Nature*, ed. David Fate Norton and Mary J. Norton (Oxford: Oxford University Press, 2000); “SBN” is the same in the edition of Selby-Bigge and Nidditch (Oxford: Clarendon Press, 1978). “EHU” is *An Enquiry Concerning Human Understanding*, ed. Tom L. Beauchamp (Oxford: Oxford University Press, 1999); “SBN” is the same in *Enquiries* ed. Selby-Bigge and Nidditch (Oxford: Clarendon Press, 1975).

14 In T 1.2.3.7 (SBN 35), he explicitly refers to *Essay* 2.14, within a few pages of the passage where Locke settles on 30” to a minute as the size of the visual minimum.

15 Antony Flew, “Infinite Divisibility in Hume’s *Treatise*,” in *Hume, a Re-Evaluation*, ed. Donald Livingston and James King (New York: Fordham University Press, 1976), 38.

16 C. D. Broad, “Hume’s Doctrine of Space,” Dawes Hicks Lecture on Philosophy, *Proceedings of the British Academy* 47 (1961): 161–76, 176.

17 H. A. Prichard, *Knowledge and Perception* (Oxford: Clarendon Press, 1950), 174.

18 Apparently, the problems of the composition of the continuum were nicknamed a “labyrinth” by Libert Froidmont of Louvain (1587–1638) in his *Labyrinthus, sive, de compositione continui* (Antwerp, 1631). The term was used again by Leibniz in the Preface to his *Theodicée*: “There are two famous labyrinths in which our reason often goes astray: one relates to the great question of freedom and necessity . . . , the other occurs in the discussion of *continuity* and of the *indivisible points* that appear to be its elements” (21). Translation by Robert Latta, in his edition of the *Monadology* (Oxford: Oxford University Press, 1898, and later editions). Bayle summarized the problem in a famous trilemma: The continuum is made up either of mathematical points, or physical points, or parts that can be divided ad infinitum. Since powerful arguments can be mounted against all three options, Bayle suggested that the disjunctive syllogism be given up and replaced by a hypothetical—if extension existed it would have to be composed in one of the three ways. But since they are all impossible, extension does not exist. Pierre Bayle, *Historical and Critical Dictionary* (1697). Translated with Introduction and Notes by Richard H. Popkin (Indianapolis: Bobbs-Merrill, 1965), 361. Bayle on atomism is discussed in Thomas Holden, “Bayle and the Case for Actual Parts,” *Journal of the History of Philosophy* 42.2 (2004): 145–64, and in his *The Architecture of Matter: Galileo to Kant* (Oxford: Clarendon Press, 2004).

19 H. Mark Pressman, "Hume on Geometry and Infinite Divisibility," *Hume Studies* 23.2 (1997): 227–44, 235. Don Baxter writes: "[Hume] thinks that indivisible parts are unextended . . . but somehow compounding them yields extended things," and refers to the section quoted above. "Hume on Infinite Divisibility," *History of Philosophy Quarterly* 5.2 (1988): 133–40, 134–35. David and Mary Norton write in their Annotation to T 1.2.3.4 (SBN 34): "Hume shows us how to experience a minimum visible, or what he takes to be a coloured point that is indivisible and unextended (having position but no spatial extension or dimension)" (T 435). Norman Kemp Smith: "No *minimum sensibile* has distinguishable parts, for the reason that it has no parts whatsoever, i.e., the sensibilia are unextended." *The Philosophy of David Hume* (London: MacMillan, 1960), 277. Marina Frasca Spada writes: "So, according to Hume, the minima of sight are unextended coloured points." *Space and the Self in Hume's Treatise* (Cambridge: Cambridge University Press, 1998), 33. Dale Jacquette ("Infinite Divisibility in Hume's First Enquiry," *Hume Studies* 20.2 (1994): 227) says, "The *Treatise* finds it necessary to introduce indivisibles by the complicated apparatus of the inkspot experiment, with its contentious strong empiricist assumption about the experiential origin of adequate ideas in impressions of sensation. Here [i.e., in the *First Enquiry*] Hume says simply 'we must allow that there are sensible extensionless physical points,' a proposition he seems to believe even his infinitist adversary will accept"; Jacquette bases his claim on EHU 12.18n (SBN 156), where Hume, however, does not speak of extensionless points but says, rather, "[w]hatever disputes there may be about mathematical points, we must allow that there are physical points; that is, parts of extension, which cannot be divided or lessened either by the eye or imagination." Cf. also Jacquette's *David Hume's Critique of Infinity* (Leiden: Brill, 2001). Harry Bracken contends: "Berkeley's minima are not Hume's. For Hume, visible extension is compounded—to put it in his paradoxical form—of unextended minima visibilia." Bracken, *Berkeley* (London: MacMillan, 1974), 28. This in turn induced David Raynor to argue that even Berkeley's minima are unextended. Raynor, "Minima Sensibilia in Berkeley and Hume," *Dialogue* 12.2 (1980): 196–200. Robert Fogelin writes: "In arguing for his own position that space (and time) are the manner in which coloured and tactile extensionless minima present themselves, Hume attacks what he takes to be all possible alternatives." Fogelin, "Hume and Berkeley on the Proofs of Infinite Divisibility," *Philosophical Review* 97.1 (1988): 47–69, 52.

Several others interpret Hume in the same way, and then take him to task. Thus already Alexius Meinong in his *Hume Studien* of 1877: "According to Hume we can perceive coloured points that are yet without extension," [but] "no one can think a colour without extension." *Abhandlungen zur Psychologie, Gesamtausgabe*, ed. R. Kindinger and R. Haller, 7 vols. (Graz, Austria: Akademische Druck und Verlagsanstalt, 1968–78), 1:41, 47. Similarly Antony Flew: "The points, or spots, which Hume has in mind, are ideal . . . and, although they constitute elements of the idea of extension, they are . . . specifically not supposed to be themselves extended." "Infinite Divisibility in Hume's *Treatise*," 269. But Hume is wrong since "even a mental picture of a point must have extension." Flew, *Hume, Philosopher of Moral Science* (Oxford: Basil Blackwell, 1987), 43. Broad claims that "so long as I am sure that I am seeing the spot at all, I am fairly sure that the sense-datum which is its visual appearance is extended, and not literally punctiform" (Broad, 166). Oliver Johnson insists that "a coloured point, if it is really visible to the eye, simply cannot be one of Hume's unextended mathematical points." Johnson, *The Mind of David Hume* (Urbana and Chicago: University of Illinois Press, 1995), 97.

- 20 *Early Responses to Hume's Metaphysical and Epistemological Writings*, ed. James Fieser, 10 vols. (Thoemmes Press: Bristol, 1999–2003), 1:90.
- 21 *Oeuvres de Descartes*, ed. Adam and Tannery, 5 vols. (Paris: Vrin, 1996), 5:270, cited from Robert Pasnau, *Mind and Extension: Descartes, Hobbes, More* (forthcoming). Now at <http://spot.colorado.edu/~pasnau/>. I was not able to find the origin of the phrase. Pasnau mentions a medieval text by an anonymous author.
- 22 Letter of Feb. 5, 1712. Gottfried Wilhelm Leibniz, *Gesammelte Schriften*, ed. C. I. Gerhardt, 7 vols. (Berlin: Weidmann, 1875–90), 2:435.
- 23 “The Extension of Body, being nothing but the cohesion or continuity of solid, separable, moveable Parts; and the Extension of Space, the continuity of unsolid, unseparable and immoveable Parts.” *Essay* 2.4.5.
- 24 Ephraim Chambers, *Cyclopaedia* (London, 1728).
- 25 Hooke, *Posthumous Works*, 97. Relevant passages are also quoted in Marina Frasca Spada’s challenging *Space and the Self in Hume's Treatise* (Cambridge: Cambridge University Press, 1998), 171ff.
- 26 Other passages stressing the distinction between points and their extended assemblages are found at T 1.2.5.21, 1.4.4.8 (SBN 61–62, 228).
- 27 Letter to Francis Hutcheson of March 4, 1740. *The Letters of David Hume*, ed. J. Y. T. Greig, 2 vols. (Oxford: Clarendon Press, 1969), 1:36.
- 28 Anonymous review printed as Article 26 of the *History of the Works of the Learned*, November and December 1739, 350–404. Reprinted in Fieser, *Early Responses*, 1:12.
- 29 Annual Congress, Canadian Philosophical Association, University of Western Ontario, May 30, 2005.
- 30 “All our simple ideas in their first appearance are deriv’d from simple impressions, which correspond to them, which they exactly represent” (T 1.1.1.7; SBN 4).
- 31 Don Garrett, *Cognition and Commitment in Hume's Philosophy* (Oxford: Oxford University Press, 1997), 58.
- 32 *The Philosophical Writings of Descartes*, ed. John Cottingham, Robert Stoothoff and Dugald Murdoch, 2 vols. (Cambridge: Cambridge University Press, 1985–86), 1:60–62.
- 33 Bayle, who may have influenced Hume’s use of the principle, says in his “Zeno of Elea” article, “we know by evident ideas that when two things are really distinct, one can be preserved or destroyed without the other being so; for whatever is really distinct from a thing is accidental to it; and . . . every thing can be preserved without that which is accidental to it” (*Dictionary*, 384). Bayle makes reference to an older discussion in Porphyry’s *Isagoge*, or introduction to Aristotle’s theory of categories. Aristotle himself takes up distinctness and separability at *Physics* I, 2–3 in connection with the monism he attributes to Parmenides and Melissus. The importance of the *Physics* passage was pointed out by Richard Bosley, Professor Emeritus at the University of Alberta in Edmonton.

34 Antoine Arnauld and Pierre Nicole, *Logic, or The Art of Thinking*, Trans. J. V. Buroker (Cambridge: Cambridge University Press, 1996), 38. Quoted from David and Mary Norton's comments on T 1.1.7.17 (T 433).

35 "Extension," in Chambers, *Cyclopaedia*.

36 Robert Smith, *A Compleat System of Opticks in four Books, viz. a Popular, a Mathematical, a Mechanical and a Philosophical Treatise*, 2 vols. (Cambridge: Crownfield; London: Austin, 1738; Bristol: Thoemmes Press, 2004).

37 James Jurin, *An Essay Upon Distinct and Indistinct Vision*, in Smith, *Compleat System of Opticks*, 2:115–71. Those unable to access the original of Jurin's essay will find a good account of it in Joseph Priestley's *The History and Present State of Discoveries Relating to Vision, Light, and Colours* (London, 1772; repr., Kraus: Millwood N.Y., 1978), 673–88. Citation is from the 1978 edition. Jurin's correspondence was recently published by Andrea A. Rusnock, who furnished her edition with a detailed and insightful introduction: *The Correspondence of James Jurin (1684–1750)*, ed. Andrea A. Rusnock (Amsterdam: Rodopi, 1986). For Jurin's biography, consult her article in the *Oxford Dictionary of National Biography*.

38 Hume had meant to submit the *Abstract* of the *Treatise* to the same publication, but after the abusive review published it as a pamphlet.

39 *The Analyst or A Discourse Addressed to an Infidel Mathematician* (London and Dublin, 1734), in *Works*, 4:53–106.

40 Published under the pseudonym Philateles Cantabrigiensis (London: T. Cooper, 1734). Discussed in *The Correspondence of James Jurin*, 38. Berkeley responded with *A Defense of Free-thinking in Mathematics in answer to a pamphlet of Philateles Cantabrigiensis, intituled Geometry no Friend to Infidelity, or a defense of Sir Isaac Newton and the British Mathematicians . . .* (Dublin, 1735), in *Works*, 4:103–41.

41 David R. Wilkins's account is found at <http://www.maths.tcd.ie/pub/HistMath/People/Berkeley/ACIndex.html>.

42 Benjamin Robins, *Mathematical Tracts*, No. 26 (London, 1761). A posthumously published collection of his pamphlets.

43 Anonymously published pamphlet, 39 pages, London 1744. Cf. *Correspondence of James Jurin*, 43.

44 Jurin offers an explanation: "The more compound an object is, or the more parts it consists of, it will, *ceteris paribus*, be more difficult for the eye to perceive and distinguish its several parts. The cause of this, we apprehend, is the difficulty of keeping the eye perfectly steady. From the same cause of the instability of the eye it must be, *ceteris paribus*, more difficult to perceive and distinguish the parts of any compound object, when each of those parts subtends a very small angle, than to see a single object of the same magnitude as one of those parts" (*Essay*, 150–51).

45 Traditionally, and not to Hume's liking, a plane was thought produced by the flowing of a right (i.e., straight) line (T 1.2.4.29; SBN 50).

46 James Franklin makes a similar point in his astute “Achievements and Fallacies in Hume’s Account of Infinite Divisibility,” *Hume Studies* 20.1 (1994), 85–101. He does not mention the wealth of vision studies available to Hume.

47 Cf. the “Advertisement” to the first *Enquiry* (EHU, SBN 2).

48 A. J. Ayer, *Hume* (Oxford: Oxford University Press, 1980), 8.

49 A. J. Ayer, *Language, Truth and Logic* (Victor Gollancz, 1936). There are many later editions.

50 Peter Millican, “Context, Aims and Structure of the *Enquiry*” in *Reading Hume on Human Understanding*, ed. Peter Millican (Oxford: Clarendon Press, 2002), 50f., n.37.

51 A very good account of the reasoning that could have led Hume to the principle is found in Don Garrett’s *Cognition and Commitment in Hume’s Philosophy*.

52 Garrett believes that these passages contain at least “a trace of the principle” (72–73).

53 Contrast recent Hume scholarship with the Hegelian linear construction of the history of philosophy, whence the designation “British Empiricism.” Wilhelm Windelband’s *Geschichte der neueren Philosophie*, 3rd ed. (Leipzig, 1904), though it promises to portray philosophy in its connection with general culture and the special sciences, does nothing of the sort. Windelband makes it appear that Hume read only Berkeley, and a little of Locke, and nothing else. Kemp Smith did much to break the stranglehold of this sort of historical construction. See *The Philosophy of David Hume* (London: Macmillan, 1941).

54 By one of *Hume Studies*’ anonymous reviewers of this essay, who quotes this passage from the *Enquiry*.