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Newton and Hume

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Abstract and Keywords

Central aspects of Hume's proposed "system of the sciences" as described in the *Treatise* are modeled on Newton's *Principia*. But, as recent scholarship has suggested, Hume's *Treatise* also bears a deeply subversive message with respect to Newtonian science. This chapter offers a revised overview of what Hume takes from Newton and what he rejects: The first part of the chapter argues that in the *Treatise* Hume adopts a version of Newton's "analytic and synthetic method" for philosophy, thereby placing a distinctively Newtonian form of explanatory reduction at the center of his own philosophical method. The second part of the chapter, on the other hand, shows that many of the most important aspects of Hume's argument in Book 1 of the *Treatise* can be understood as critical of core conceptual and ontological commitments of Newton's mechanics as developed in the *Principia*.

Keywords: Newton, Hume, system of the sciences, analytic and synthetic method, explanatory reduction, absolute space, geometry, Rule 3, force

IN his *History of England* (1754–62), David Hume offered what was to be his final published assessment of Isaac Newton:

> In Newton this island may boast of having produced the greatest and rarest genius that ever arose for the ornament and instruction of the species. Cautious in admitting no principles but such as were founded on experiment; but resolute to adopt every such principle, however new or unusual: From modesty, ignorant of his superiority above the rest of mankind; and thence, less careful to accommodate his reasonings to common apprehensions: More anxious to merit than acquire fame: He was from these causes long unknown to the world; but his reputation at last broke out with a lustre, which scarcely any writer, during his

> own lifetime, had ever before attained. While Newton seemed to draw off the veil from some of the mysteries of nature, he shewed at the same time the imperfections of the mechanical philosophy; and *thereby* restored her ultimate secrets to that obscurity, in which they ever did and ever will remain. (HE VI 542; emphasis added)

This passage leaves no doubt as to Hume's admiration for Newton, whom he calls the "greatest and rarest genius that ever arose." But it is remarkable that as a historian Hume chooses to focus attention on two aspects of Newton's legacy that others might not have considered the most significant: first, Hume emphasizes that Newton decisively undermined the mechanical philosophy of Descartes and Boyle, in so doing ("thereby") ensuring that the ultimate workings of nature would remain unknowable. Thus, in Hume's hands, Newton's achievement in his *Mathematical Principles of Natural Philosophy* (1687, hereafter *Principia*) is turned into an argument for skepticism about fundamental ontology,[1] when it is by no means obvious that Newton and his followers understood his achievement as an argument for any such thing.

Second, Hume here presents Newton's so-called *analytic and synthetic method* in natural philosophy as a combination of cautious experimental foundationalism ("admitting no principles but such as were founded on experiment") and bold extrapolation ("resolute to adopt every such principle, however new or unusual") lacking in any real (p. 674) concern for the constraints of common sense ("thence, less careful to accommodate his reasonings to common apprehensions"). Hume, of course, was not usually one to praise a project for straying too far beyond common sense, and readers familiar with his philosophy would have noticed the backhanded nature of this compliment: as Hume writes in his *Enquiry Concerning Human Understanding* (1748), practitioners of a "mitigated scepticism" will not "be tempted to go beyond common life, so long as they consider the imperfection of those faculties which they employ, their narrow reach, and their inaccurate operations" (EU 12.3.25/162).

These two planks of Hume's assessment of Newton in his *History of England*—his backhanded treatment of Newton's disregard for common sense and his praise for Newton's contribution to the cause of ontological skepticism—serve to alert us to a not insignificant tension between Hume's views and those of the camp of mainstream Newtonians whose influence was by then felt everywhere in British philosophy and science. We can compare Hume's assessment, for example, with that of Samuel Clarke, the most influential early spokesperson for the Newtonian cause, who, in the context of using the authority of Newton's science to offer a detailed criticism of Spinoza, writes that "after all the discoveries of later ages," we are justified in agreeing with Ecclesiasticus that "There are yet hid greater things than these, and we have seen but a

few of his works. For the Lord hath made all things; and to the godly hath he given wisdom" (1705: Part XI, 81–83).[2] Clarke thus inserts Newton as an important recent step in a godly and progressive unveiling of God's works, whereas Hume's philosopher can do without God's beneficience so long as he "proportions his belief to the evidence" (EU 10.1.4/110).[3]

This tension between Hume's assessment and that of more mainstream eighteenth-century British Newtonians raises significant questions regarding the true relationship between Hume's philosophy and Newton's. Hume has often been taken for a Newtonian, and for good reason: The subtitle of Hume's *Treatise of Human Nature*, "An attempt to introduce the experimental method of reasoning into moral subjects," makes it seem as though Hume's aim is to extend the methods of natural philosophy into the study of human nature. This conclusion is supported, as well, by Hume's comment in the *History* to the effect that Newton's experimental method is a decisive step on "the only road, which leads to true philosophy" (HE VI, 542). Moreover, there are passages in the *Treatise* and in Hume's later writings that strongly suggest that he wishes to be seen as the Newton of the human sciences.[4] But, in recent years, scholars have begun to suspect that Hume's relationship to Newton is in fact quite a bit more complicated—and more interesting—than this. On this view, Hume in fact has a dual agenda with respect to Newton: on the one hand, central aspects of Hume's proposed "system of the sciences" are in fact inspired and modeled on Newton's success in the *Principia*. On the other, Hume's *Treatise* is also bears a deeply subversive message with respect to Newtonian science.[5]

The aim of this chapter is to offer a revised overview of what Hume takes from Newton and what he rejects. Our discussion focuses on Hume's *Treatise* (1739), the work in which Hume's relationship with Newton is perhaps displayed most extensively and most fully. In the first part of the paper, we argue that, in the *Treatise*, Hume advocates a version of (p. 675) the analytic and synthetic method of philosophy as described in Newton's Principia and *Opticks* . This means that Hume places a form of explanatory reduction at the center of his own philosophical method. In the second part of the paper, we show that many of the most important aspects of Hume's argument in Book 1 of the *Treatise* can be understood as critical of core conceptual and ontological commitments of Newton's mechanics as developed in the *Principia*.

I Hume as Newtonian

I.1 The Analytic and Synthetic Method

When Hume wrote his *Treatise of Human Nature* in the mid-1730s, Newton's *Principia* had already been in circulation for four decades, its first edition having appeared in 1687. And although the complete victory of Newtonian ideas and methods still lay in the future—with plenty of resistance still to be found in the great academies of France and Berlin[6]—they had already gathered sufficient momentum in Britain so that Berkeley could see reason to publish a pamphlet complaining of the loss of "free-thinking" in the field of mathematics.[7]

Although the young Hume was in many respects a dissenter from Newtonian orthodoxy, his *Treatise* was nonetheless consciously modeled on the explanatory-reductive method put to such extraordinary effect in Newton's *Principia*. This method is most clearly articulated in the "Queries" to Newton's *Opticks* . There, he explains that there exists a general method for the "investigation of difficult things," which he calls the "analytic and synthetic method." This is a two-step investigation that begins in (1) a movement from experiment and observation to general causes "by induction"; and then continues to (2) a second stage, which "consists in assuming the causes discover'd, and establish'd as principles, and by them explaining the phaenomena proceeding from them" (1730: 404–405).[8] In the case of the *Principia,* the general causes that have been discovered by induction are the "laws of motion" and the law of gravitation, all formulated in terms of a scheme of fundamental concepts such a *force* and *mass* presented in the definitions at the beginning of the work. Newton then "assumes the causes discover'd" and proceeds to explain the motions of celestial bodies, terrestrial projectile motion, the rise and fall of the tides, and the shape of the earth's surface—all of them by way of the basic terms he has assumed at the outset.[9] In the Introduction to his *Treatise,* Hume explicitly says that such explanatory reduction of the phenomena is the aim of his work:

> [W] e must endeavor to render all our principles as universal as possible, by [i] tracing up our experiments to the utmost, and [ii] explaining all effects from the simplest and fewest causes. (T Intro. 8/xvii)

(p. 676)

In this passage, we see the same two-step method advocated by Newton in his *Principia,* which first seeks to "trace" upward from empirical data toward a small number of terms

or causes and with these seeking to "explain all effects." Hume rehearses this view of the aim of scientific reasoning time and again in subsequent works.[10]

Examining the *Treatise* in light of this methodological declaration reveals that Hume's work is in fact consciously constructed in imitation of the *Principia.* Like the *Principia,* Hume's *Treatise* begins with the presentation of a scheme of fundamental "elements" that Hume has derived from his experiments and that are then to be used in explaining the rest of the phenomena. This presentation is to be found in the first thirteen pages of the body of the *Treatise* (Book 1, Part 1, Sections 1–4), whose subject, Hume informs us, "may be consider'd as the elements of this philosophy" (T 1.1.4.7/13).[11]

What, then, are the "elements" of Hume's philosophy? It would appear that Hume introduces six fundamental "elements," of which two are basic psychological entities or objects, and four are operations of the mind carried out with respect to them.[12] The basic psychological objects are *impressions* and *ideas,* which Hume describes as follows:

> *All* the perceptions of the human mind resolve themselves into two distinct kinds, which I shall call *impressions* and *ideas*. The difference betwixt these consists in the degrees of force and liveliness, with which they strike upon the mind …
>
> Those perceptions, which enter with most force and violence, we may name *impressions;* and under this name I comprehend all our sensations, passions and emotions, as they make their first appearance in the soul.
>
> By *ideas* I mean the faint images of these in thinking and reasoning; such as, for instance are all the perceptions excited by the present discourse, excepting only, those which arise from sight and touch. (T 1.1.1.1/1)[13]

In addition, Hume introduces us to four fundamental operations of the mind. The first of these is the operation of *copying* an impression, whose result is the production of an idea corresponding to this impression (T 1.1.2.1/8).[14] Second is the purposive *uniting* and *separation* of ideas by way of the imagination (T 1.1.4.1/10). Third is the operation of *association,* which is a force that works automatically on ideas and establishes relations among them without the assistance of any active effort on the part of the mind:

> ['T]is impossible the same simple ideas should fall regularly into complex ones (as they commonly do) without some bond or union among them, some associating quality, by which one idea naturally introduces another… . [This is] a gentle force, which commonly prevails, and is the cause why, among other things, languages so nearly correspond to each other… . The qualities, from which this association arises, and by which the mind is after this manner convey'd from one idea to

> another, are three, vis., *resemblance, continuity* of time and space, and *cause* and *effect.* (T 1.1.4.1/10–11)[15]

In addition to these three operations, it can be argued that Hume ends up relying on a fourth operation of the mind that is only touched on in Sections 1–4 of Book 1, Part 1. (p. 677) This is the transfer of "force or liveliness" from an impression to an idea and, from there, possibly, to other ideas. Although the force and liveliness of impressions and ideas is discussed in the first lines of Book 1, the transfer of force and vivacity is discussed in an explicit fashion only later, where Hume writes that:

> [W] hen any impression becomes present to us, it not only transports the mind to such ideas as are related to it, but likewise communicates to them a share of its force and vivacity. (T 1.3.8.2/98)

This operation is discussed more thoroughly in the corrections to Book 1 that Hume published in 1740, leaving the impression that Hume's understanding of the importance of this operation grew as he progressed in writing the *Treatise* and thereafter.

In Newton's method of analysis and synthesis, the derivation of a scheme of fundamental terms by induction is followed by a second stage of investigation, in which the general causes discovered in this way are assumed as given and used to explain the phenomena. And, indeed, the body of Hume's *Treatise,* after the presentation of the elements of his system in Book 1 (the stage of "analysis"), consists of precisely such a second stage (the stage of "synthesis"), in which the elements of Hume's system are assumed, and the phenomena of human experience are given explanations in terms of these elements.[16]

Don Garrett has noted that the British philosophical tradition follows Locke in developing a pattern of reductive argument unknown in the writings of continental philosophers such as Descartes, Spinoza, or Leibniz. In such arguments, a given fundamental concept under investigation is said to "consist" of some other quality or qualities. Frequently, it is said that these other qualities are "what is meant" when we speak of the fundamental concept in question (Garrett 1997: 36). Hume's explanatory reductions in the *Treatise* follow this same pattern and are, in many cases, marked by an explicit statement to the effect that the concept or phenomenon being reduced is in fact "nothing but" some arrangement of Hume's psychological elements. Because Hume believes we have no access to anything other than the perceptions of things present in our own minds (T 1.2.6.7/67–8), he feels free to argue that if we want to understand the nature of some object of interest to us, we cannot dispense with an examination of how this same object is constituted in our understanding of it.[17] This move permits him repeatedly to reduce the objects of human experience to those operations of the human mind that constitute the entirety of what we

can know of these objects, saying that, in fact, the object in question is “nothing but” a certain set of psychological entities and operations.

Given the way that the term *reduction* is often used in present-day philosophy, there is here a palpable danger that Hume’s *nothing but* statements will end up being understood as though he means to say that the things he is reducing to psychological terms do not actually exist. But Hume’s *nothing but* statements are not eliminativist. Indeed, even in contemporary philosophy, this interpretation of explanatory reduction in science is often mistaken. To say that water is “nothing but” atoms of hydrogen and oxygen arranged in a certain fashion is not to say that what is usually called *water* does not exist and that only atoms of hydrogen and oxygen exist.[18] In fact, quite (p. 678) the opposite is the case: such reductions often require us to make changes in the way we understand the world, but their aim is principally to permit us to understand how and why an object such as water comes to exist with the properties that we know it to have. This should be obvious from Newton’s *Principia.* Newton does strive to show that, for example, the orbital motion of the planets is *nothing but* the force of gravity acting in accordance with the inverse-square law, together with the inertial motion of the moving body. But this does not mean that orbital motion does not exist! What Newton is doing when he reduces orbital motion to its components is showing us how and why the orbital motions of the planets come to exist with the properties we know them to have.

Hume’s “nothing but” arguments should for the most part be read in the same way. It is true that, on occasion, Hume’s explanatory reductions have an eliminationist edge to them (Loptson 1998). For example, Hume is quite clear that he thinks the Aristotelian philosophical category of *substance* should be discarded from our philosophical vocabulary, so that when he reduces the category of *substance* to psychological terms, it’s easy to draw the conclusion that such reductions are part of an overall skeptical strategy of showing that the things he reduces in this way do not exist.[19] But in general Hume’s *nothing but* statements do not arise as a result of a motive of this kind. They stem from the same aim as Newton’s explanatory reductions, and they are concerned with things such as *time* and *space, causation, belief, reality,* the *self, sympathy,* and *morals* that Hume has no interest in saying do not exist. Indeed, all of these are things to which Hume refers time and again in the *Treatise* as though they do exist. His aim is rather to show us how and why these things exist with the various properties that we know them to have and, as a consequence, to show why we should discard properties that are wrongly attributed to them. In short, we should assume that Hume intends his “nothing but” statements to amount to explanations, rather than eliminations, unless he gives us good reason to think he has something else in mind.

Thus, for example, Hume rejects the medieval conception, adopted by Locke, according to which the mind has the power to "abstract" from the particulars of a series of similar objects, creating an abstract idea that consists of the essential and unifying aspects of an entire class. Instead, he wishes to show that what we call *abstract ideas* can, in fact, be reduced in their important properties to copies of particular impressions. He thus opens by informing his readers that abstract ideas are "nothing but" individual ideas responding in a certain fashion to the mention of a word that invokes all of them. As he writes:

> A great philosopher has disputed the receiv'd opinion … , and has asserted, that all general ideas are **nothing but** particular ones, annexed to a certain term, which … makes them recall upon occasion other individuals, which are similar to them. (T 1.1.7.1/17, emphasis added)[20]

Hume then explains how this reduction works. His first step is to argue that since ideas are nothing but copies of impressions, and impressions are always of a particular sight or sound, the ideas that are copies of these impressions must always be particular (p. 679) as well (T 1.1.7.6/19–20). We see, therefore, that given the nature of impressions and of the copying operation, all ideas must be particular ideas. What happens, then, when we deploy a general term, such as the word *triangle* or the word *bird,* which does not refer to any particular triangle or bird? Each such word, Hume tells us, triggers the activity of all the ideas that were ever associated with it (T 1.1.7.7/20). But because the mind can have only one idea fully before it at a time, the others remain on the sidelines of our consciousness, ready to be recalled if needed.[21] Hume goes on to discuss how general words can stand in for general ideas in conversation by invoking a particular simple idea as a stand-in, while at the same time activating other simple ideas in potential so that they are available to come to the fore as needed.[22] By this mechanism, we are able to think and speak in abstract terms without ever actually engaging in an operation of the mind that involves abstraction.

Hume's reduction of Scholastic terms such as *substance* and *abstraction* in *Treatise* 1.1.6–7 is in a sense preliminary. Hume's real interest is the reduction of the new natural philosophy to psychological entities and mechanisms. This project gets under way with Hume's reductions of the categories of *space* and *time* in Part 2; and reaches a climax in Part 3, in which not only *causation,* but also the very distinction between what is *real* and what is not are reduced to operations of human psychology. Thus, regarding space, Hume famously argues that the idea of space or extension is "nothing but" the idea of visible or tangible points distributed in a certain order (T 1.2.5.1/53; T 1.2.5.21/62):

> The table before me is alone sufficient by its view to give me the idea of extension. This idea, then, is borrow'd from, and represents some impression, which this moment appears to the senses. But my senses convey to me only the impressions of colour'd points, dispos'd in a certain manner. If the eye is sensible of any thing farther, I desire it may be pointed out to me. But if it be impossible to shew any thing farther, we may conclude with certainty, that the idea of extension is **nothing but** a copy of these colour'd points, and of the manner of their appearance. (T 1.2.3.4/34; emphasis added)

Regarding our concept of time, Hume argues that this, too, can be seen to be "nothing but" an abstract idea derived from primary distinct impressions succeeding one another:

> The ideas of some objects it [i.e., the mind] certainly must have, nor is it possible without these ideas ever to arrive at any conception of time; which since it appears not as any primary distinct impression, can plainly be **nothing but** different ideas, or impressions, or objects dispos'd in a certain manner, that is, succeeding each other. (T 1.2.3.10/37; emphasis added)

By the same token, Hume says that necessity is "nothing but" an internal impression reflecting the determination of the mind to pass from one object to the other in accordance with our previous experience: **(p. 680)**

> These instances are in themselves totally distinct from each other, and have no union but in the mind, which observes them, and collects their ideas. Necessity, then, is the effect of this observation, and is **nothing but** an internal impression of the mind, or a determination to carry our thoughts from one object to another… . Upon the whole, necessity is something, that exists in the mind, not in objects; nor is it possible for us ever to form the most distant idea of it, consider'd as a quality in bodies. Either we have no idea of necessity, or necessity is **nothing but** that determination of the thought to pass from causes to effects and from effects to causes, according to their experienc'd union. (T 1.3.14.20–2/165–6)[23]

Similarly, when we speak of our *belief* in the reality of objects, what we mean is that "those ideas, to which we assent, are more strong, firm and vivid" (T 1.3.7.8/97). As Hume writes, *belief* and *assent* are nothing but this greater force or vivacity that accompanies certain ideas:

> Thus it appears, that the *belief* or *assent*, which always attends the memory and senses, is **nothing but** the vivacity of those perceptions they present; and that this alone distinguishes them from the imagination. To believe is in this case to

> feel an immediate impression of the senses, or a repetition of that impression in memory. 'Tis merely the force and liveliness of the perception, which constitutes the first act of the judgment. (T 1.3.5.7/86; emphasis added to "nothing but.")

In the same way, we find that Hume's "nothing but" statements signal his reduction of numerous other phenomena to his basic vocabulary of terms, including the *continuous existence* of objects (T 1.4.3.2/219; T 1.4.6.7/255), the *self* (T 1.4.6.4/252–3),[24] *sympathy* (T 2.2.9.13/385–6; T 2.3.6.8/427), and *virtue* and *vice* (T 3.1.2.3/471; T 3.3.5.1/614). Together with Hume's presentation of the elements of his philosophy in *Treatise* 1.1.1–5, this systematic effort to show that the principal phenomena of our experience can be reduced to these same elements in the rest of the work constitutes the Newtonian template of analysis and synthesis around which the *Treatise* is built.[25] To explain the most widely recognized aspects of our experience in terms of a scheme of simplest and fewest terms was, for Hume, the method of the *Principia,* and he hoped that the science of the *Treatise* could win both scholarly and public acclaim in the same way that Newton's work had.[26]

I.2 Hume's Associative Laws and Newton's Law of Gravitation

In addition to embracing a version of Newton's method of analysis and synthesis, Hume's associative operation of the mind, mentioned earlier, is governed by three laws of "attraction" that are presented in self-consciously Newtonian terms. In the "Abstract" published anonymously after the appearance of the *Treatise*, Hume writes that if anything gives the author of this work "so glorious a name as that of an *inventor*, 'tis the (p. 681) use he makes of the principle of the association of ideas" (TA 35/661). Hume was not, of course, the first to describe the human mind in terms of the functioning of a fundamental associative mechanism.[27] But he was the first to have systematically reduced the associative action of mental operations (in what Hume calls the "imagination") to three natural relations: those of resemblance, contiguity, and causation. In particular, causation is shown to be that relation characteristic of the human imagination that governs any factual claim beyond what is immediately evident to the senses and memory. In the *Treatise*, Hume draws attention to the parallel between his laws of attraction and the effects of Newtonian gravitation in the natural world:

> These are therefore the principles of union or cohesion among our simple ideas, and in the imagination supply the place of that inseparable connexion, by which they are united in our memory. Here is a kind of *attraction*, which in the mental world will be found to have as extraordinary effects as in the natural, and to shew

> itself in as many and as various forms. Its effects are every where conspicuous; but as to its causes, they are mostly unknown, and must be resolved into original qualities of human nature, which I pretend not to explain. (T 1.1.4.6/12; emphasis in original)

Hume's associative principle is thus a kind of attraction governing the mental world in a way that is seen as parallel to the principle of gravitation in the physical world, and Hume suggests it is no less successful an explanation than Newtonian attraction. Indeed, in the Introduction to the *Treatise,* Hume had claimed that through judiciously collected experiments and cautious observations of human life "we may hope to establish … a science, which will not be inferior in certainty, and will be much superior in utility to any other of human comprehension" (T Intro. 10/xix). Here, Hume suggests that in providing the principles of cohesion among our simple ideas, he has delivered, at least in part, on the Introduction's promissory note.

Nevertheless, this passage from the *Treatise* also gives a skeptical slant to this achievement that already foreshadows Hume's summation of Newton's achievements in the *History of England* by emphasizing that the ultimate causes of the principle of association must be unaccountably located in the "original qualities of human nature, which I pretend not to explain." This passage closely parallels a famous passage from the General Scholium to the Second Edition of the *Principia* in which Newton had likewise declined to explain the causes of his law of universal gravitation. Newton's famous *hypotheses non fingo* ("I feign no hypotheses")[28] is the model for Hume's refusal here to speculate concerning the causes of the laws of attraction, as well as for Hume's other declarations against "hypothesis" in philosophy (e.g., T 1.4.7.14/272).

But although on the surface Hume's reticence to enter into ungrounded speculation is very much akin to Newton's, there is also a significant gap between their views. In the same passage just quoted, Hume continues as follows:

> Nothing is more requisite for a true philosopher, than to restrain the intemperate desire of searching into causes, and having established any doctrine upon a sufficient **(p. 682)** number of experiments, rest contented with that, when he sees a farther examination would lead him into obscure and uncertain speculations. In that case his enquiry would be much better employed in examining the effects than the causes of his principle. (T 1.1.4.6/13)

Hume here identifies the "true philosopher" with the person who knows how to cease from further inquiry into his subject at the point where the effects susceptible to careful examination cannot responsibly sustain speculation into causes that are more deeply hidden. Putting an end to inquiry into causes avoids getting one involved in an obscure

and uncertain enterprise—the sort that leads to useless speculations and invariably ends up encouraging the acceptance of false beliefs. Newton, despite his campaign against the fantastic "hypotheses" of his predecessors, was in practice quite far from the restraint that Hume advocates. In fact, the *Principia* contains Scholia dealing with subjects from God's nature to the character of the human nervous system—subjects that Hume would evidently have considered to be beyond self-imposed limits to inquiry that a "true philosopher" would have accepted on himself had the effects under examination been such as they were in the *Principia*. Further on, we will see further examples of Hume's hesitations concerning the *Principia* in this regard.

There is a second sense in which Hume's treatment of his laws of association is un-Newtonian. Recall that the associative mechanism is not an exceptionless law. It is "a gentle force, which commonly prevails." Of course, even the Newtonian force of gravitation only prevails *most* of the time—a wind blowing up a falling leaf will appear to neutralize the effect of gravitation, too. But, methodologically, Hume's stance on this point deprives him of a powerful Newtonian evidential strategy, which consists of showing how expected deviations from regularities follow from the same underlying mechanisms.[29]

II Hume as Anti-Newtonian

As we have argued, Hume saw his philosophy as adopting the two-step procedure of the *Principia,* deriving a small vocabulary of simple terms or causes from observed data by induction and then explaining the rest of experience by means of these terms. But Hume's project was not only a Newtonian one. His ambitions were anti-Newtonian as well, being motivated by the sense that Newton and his followers were on the verge of interpreting the great physicist's triumphs as justification for the establishment of a rigid new scholasticism and natural religion. In the rest of this paper, we consider new arguments and evidence in support of the contention that Hume's *Treatise* should also be seen, in part, as advancing a systematic attack on Newton's science. In this regard, we here consider (1) Hume's rejection of Newton's introduction of absolute space and time into physics; (2) Hume's attack on Newton's claim that the exactness of geometry makes mathematical physics an exact science; (3) Rule 7 of Hume's "Rules by which to judge (p. 683) of causes and effects," which seeks to limit Newton's claims to be able to extend empirically derived laws to the microworld and to the ends of the universe; and (4) Hume's reduction of the category of *force* to psychological terms, amounting to the claim that the Newtonian physics describes entities that are not mind-independent.

II.1 Absolute Space and Time

Almost everything in Hume's *Treatise* 1.2, which is devoted to a treatment *Of the ideas of space and time,* can be seen as taking issue with Newton's *Principia*.[30] Hume's criticism of the vacuum and of absolute space and time do not just takes sides on questions of traditional philosophical interest; they challenge central claims of the *Principia.* [31] And his argument against the infinite divisibility of space seems, in light of Berkeley's similar arguments that are explicitly directed against Newton, to be an attack on the deployment of fluxions and reasoning with infinitisseminals in mechanics.[32] In this section, we look more carefully at Hume's attack on the Newtonian treatment of absolute space and time. Although previous scholarship has touched on this aspect of Hume's critique of Newton,[33] we believe Hume's attack here is even more significant than has perhaps been appreciated, representing a rejection of a Newtonian claim to be able to attain fundamental knowledge of physical reality beyond what is reported by the senses.

In the Scholium to the definitions at the front of the *Principia*, Newton distinguishes the abstractions "true time" and "true space" from the time and space that are the subjects of common discourse. As he explains, space and time as normally considered are relative terms, derived "solely with reference to the objects of sense perception."[34] In the *Principia*, Newton also distinguishes between absolute space and true space, as well as between absolute time and true time—using the concepts of "true space" and "true time" for the derivation of true accelerations. Nevertheless, as the Scholium makes perfectly clear, it is not in this sense that the terms "true time" and "true space" are being used here. Rather, Newton proposes that there exist an absolute space and time, each of which is "in and of itself and of its own nature, without reference to anything external."[35] Regarding such absolute space and time, Newton daringly argues that its existence can be demonstrated experimentally.[36] Moreover, Newton introduces it into his system of the world in a corollary to Prop. 12 of Book 3, where he writes that "the common center of the earth, sun, and all the planets is to be considered the center of the universe … which is at rest";[37] and in the corollary to Prop. 14, he derives from this hypothesis the conclusion that "The fixed stars also are at rest" (1687: 819).

Whether the *Principia* really provides readers with the tools necessary to follow Newton to these conclusions was something that Hume doubted.[38] Hume, of course, argues that what we know of space is "nothing but the idea of visible or tangible points distributed in a certain order" (T 1.2.5.1/53; emphasis removed)[39] and that what we know of time "can plainly be nothing but different ideas, or impressions, or objects dispos'd in a certain manner, that is, succeeding each other" (T 1.2.3.10/37).[40] Like Newton, Hume thus understands space and time in their conventional usage to be derived exclusively

(p. 684) from sense experience. But Hume breaks with Newton on the question of whether human beings can know anything beyond this. An abstract idea such as that of space or time is, for Hume, nothing more than a particular instance held before the mind as a kind of "short-cut" or placeholder while other concrete instances of our past experience crowd around.[41] When discussing space and time, what we have before us is therefore experienced extensions and durations, all of which are obviously relative. Indeed, Hume does not believe that we can so much as conceive of an absolute space or time independent of the objects of sense experience. As he writes concerning absolute time:

> [T] hat we really have no such idea, is certain. For whence shou'd it be deriv'd? Does it arise from an impression of sensation or of reflection? Point it out distinctly to us, that we may know its nature and qualities. But if you cannot point out *any such impression*, you may be certain you are mistaken, when you imagine you have *any such idea*. (T 1.2.5.28/65; emphasis in the original)[42]

At the end of Part 2, Section 5, Hume announces that, having explained what is in fact meant by space and time, he is "now prepar'd to answer all the objections that have been offer'd, whether deriv'd from *metaphysics* or *mechanics*" (T 1.2.5.22/62; emphasis in original)—the reference to "*mechanics*" in this context indicating that he is responding to Newton (whereas "*metaphysics*" apparently refers to the claims of Scholastic and Cartesian opponents).[43] Hume then proceeds to show how one may construct what is *called* an idea of absolute space or absolute time although the idea in question is in fact nothing more than a repetition of one's idea of relative space and time (T 1.2.5.22–9/62–5). Of course, Hume knows quite well that when Newton refers to absolute space and time, he isn't talking about our *ideas* at all. Newton writes explicitly of time and space, "in and of itself and of its own nature, without reference to anything external."[44] Hume addresses this claim in a crucial passage at the end of his discussion of time and space, in which he suggests that such knowledge is "beyond the reach of human understanding":

> 'Twill probably be said, that my reasoning makes nothing to the matter in hand, and that I explain only the manner in which objects affect the senses, without endeavouring to account for their real nature and operations… . I answer this objection, by pleading guilty, and by confessing that *my intention never was to penetrate into the nature of bodies,* or explain the secret causes of their operations. For … I am afraid, that such an enterprise is beyond the reach of human understanding, and that *we can never pretend to know body otherwise than by those external properties, which discover themselves to the senses.* (T 1.2.5.25/63–4; emphasis added)

Although this passage refers to the nature of bodies, the context is the climax of his discussion of the nature of time and space.[45] Indeed, Hume here criticizes the Newtonian conception of absolute time and space using the same language that Newton uses in the Scholium quoted earlier: whereas Newton writes that we can know time or space *as it is in its own nature, without reference to anything external*—Hume responds that the "external" properties by which things are known to our senses are all we have or can ever have in trying to know about anything.[46] (p. 685)

One might object that Hume is here conflating Newton's treatment of space and time with his treatment of bodies. But Hume's point is precisely that if one takes Newton as being committed to demonstrating all aspects of his science from the phenomena, there can be nothing that is said of time and space other than that which can be derived from the appearances of bodies. Indeed, in a late addition to this argument of the *Treatise* from 1740, Hume takes this line of argument to a clear point, emphasizing that "the Newtonian philosophy," if "rightly understood," in fact allows nothing to be said about the essential nature of space (i.e., whether it is a vacuum) except to the extent that space is known from the appearances of bodies in it:

> If we carry our enquiry [concerning the invisible and intangible distance, interpos'd betwixt two objects] beyond the appearances of objects to the senses, I am afraid, that most of our conclusions will be full of scepticism and uncertainty. Thus if it be ask'd, whether or not the invisible and intangible distance be always full of *body* … I must acknowledge, that I find no very decisive arguments on either side… . If *the Newtonian* philosophy be rightly understood, it will be found to mean no more. A vacuum is asserted: That is, bodies are said to be plac'd after such a manner as to receive bodies betwixt them, without impulsion or penetration. The real nature of this position of bodies is unknown. We are only acquainted with its effects on the senses, and its power of receiving body. (T 1.2.5 n12.2/639; emphasis in the original)

In the original text of the *Treatise* from 1739, Hume then proceeds to comment on the Newtonian project of attempting to gain knowledge of absolute time and space, saying that he "cannot approve of their ambition" until an example of success can be brought forward. He then rehearses his famous argument about resting contented with a given level of philosophical achievement:

> As to those who attempt any thing farther, I cannot approve of their ambition, till I see, in some one instance at least, that they have met with success. But at present *I content myself* with knowing perfectly the manner in which objects affect my senses, and their connections with each other, as far as experience informs me of

> them. *This suffices* for the conduct of life; and *this also suffices for my philosophy, which pretends only to explain* the nature and causes of our perceptions, or impressions and ideas. (T 1.2.5.26/64; emphasis added)

Usually unnoticed by scholars is that this passage, too, includes an oblique reference to Newton's *Principia* aimed at making it clear who Hume's target is. The reference is to one of the most famous passages in the *Principia*—the second to last paragraph of the General Scholium, already mentioned, in which Newton rejects criticism that he has not described the causes of his proposed force of gravitation, asserting that he will feign no hypotheses. This paragraph ends with the following sentence:

> *[I] t is enough* that gravity really exists and acts according to the laws we have set forth and *is sufficient to explain* all the motions of the heavenly bodies and of our sea. (1687: 493; emphasis added)

(p. 686)

This Newtonian assertion that "it is enough" that gravity acts according to the laws proposed and is "sufficient to explain" the movements of the planets and the sea is parallel to Hume's assertion that he is "content" with the laws of perception and association, which achievement "suffices … to explain" the nature and causes of our perceptions. In other words, Hume commandeers Newton's famous "It is enough" argument (made in the context of a defense of an account of gravity that is based entirely on its "external properties"), turning it back against Newton himself. As Hume argues, if "It is enough" that we describe gravity by its "external properties," it should also be enough to describe time and space in such "external" terms as well. And this is precisely what Hume believes he has provided in his analysis of time and space.[47]

II.2 The Exactness of Geometry

If Hume's attack on absolute space and time in *Treatise* 1.2 is aimed at Newton's claim to have attained fundamental knowledge of physical reality beyond what is reported by the senses, his attack on geometry takes on another Newtonian commitment, the conceit to have brought a near-perfect exactness and certainty into physical science.

As Alan Shapiro and others have emphasized, one of the principal characteristics that recommended Newton's philosophy to its own time was its ability to introduce a very great degree of certainty into natural philosophy. Natural philosophy in seventeenth-century England had largely freed itself from the presumption that real science is demonstrative in character and was, in Boyle's day, inclined mostly to careful experimentation without insisting on better than probable results. In this context,

Newton's aim was to show that probabilistic natural philosophy was not good enough. As he wrote in his first published paper, what he was after was "not an hypothesis but most rigid consequence … without any suspicion of doubt."[48]

It is therefore no accident that Newton's Principia and *Opticks* are, despite their differences, written as treatises in geometry—the very paradigm of what was considered to be an infallible science.[49] And, indeed, the first paragraphs of the *Principia* are devoted to a discussion of what Newton calls a "rational mechanics," which is the rendering of mechanics as a "science, expressed in exact propositions and demonstrations." According to Newton, the "exactness" of geometry, which is perfect, permits the mechanic who applies geometry to his discipline to become "the most perfect mechanic of all."[50] His point is that his method permits the infallibility of a demonstrative science to be applied, at least very nearly, to moving bodies.

As is well known, Hume had little sympathy for the Scholastic and Cartesian project of attaining knowledge "without any suspicion of doubt," and he had no more sympathy for these claims when they were made by Newton or his followers. And in Book 1, part 2 of the *Treatise,* he embarks on an examination of the "foundation of mathematics" (T 1.4.2.22/198)[51] in which he challenges the idea that geometric proofs possess the kind of perfection that can finally dispel imprecision and doubt. The only named target is Isaac Barrow, Newton's mentor (T 1.2.4.21/46). **(p. 687)**

Hume's argument in this section is straightforward: geometry is a science conducted by comparing constructions of points, lines, and surfaces, either on paper or in the mind of the geometer. Everyone admits that the truths of geometry are not to be judged by the "loose draughts" that mathematicians put to paper. No line we draw is really perfectly straight, and no surface is perfectly smooth (T 1.2.4.33/53). The question, then, is where the claim to absolutely certain and precise conclusions in geometry comes from. Hume believes it must derive from the supposition that the construction and comparison of geometric figures is absolutely certain and precise when conducted in the imagination. But Hume points out that this impression of absolute certainty and precision in our manipulation of imaginary geometric figures is illusory: "As the ultimate standard for these figures is deriv'd from nothing but the senses and imagination, 'tis absurd to talk of any perfection beyond what these faculties can judge of" (T 1.2.4.29/51). In fact, human imagination is capable only of constructing and manipulating *rough* geometric figures. Thus, anything we do with geometry is only roughly right:

> [Geometric proofs] are not properly demonstrations, because built on ideas, which are not exact, and maxims, which are not precisely true. When geometry decides any thing concerning proportions of quantity, we ought not to look for the utmost

> *precision* and exactness. None of its proofs extend so far. It takes the dimensions and proportions of figures justly; but roughly and with some liberty. (T 1.2.4.17/45; emphasis in the original)[52]

Hume concludes that geometry "can never afford us any security" if our claim is, by its means, to have attained a certain understanding of nature.[53]

The heart of Hume's attack on the infallibility of applied geometry is based on the absence of any real equality between geometric figures. Geometry proceeds entirely on the assertion that the extension of one line segment is equal to that of another. These equalities are judged of by the mind "without comparing the number of their minute parts" and often have to be corrected when we compare both segments "by use of some common and invariable measure, which being successively applied to each, informs us of their different proportions." Indeed, this process of correction toward ever-greater precision must continue indefinitely in accordance with the precision of the instrument we use in measuring. But because no instrument will ever measure the most minute differences, "we clearly perceive, that we are not possess'd of any instrument or art of measuring, which can secure us from all error and uncertainty" (T 1.2.4.24/47–8). Indeed, "'tis for want of such a[n absolute] standard of equality in extension, that geometry can scarce be esteem'd a perfect and infallible science" (T 1.3.1.5/71).[54]

Read in light of Newton's famous claim to have introduced exactness into mechanics, Hume's argument amounts to this: In the absence of any absolute standard against which to measure, Newton does not even have the ability to judge two lengths or velocities as equal to one another, except as an approximation—hardly an impressive achievement for one aspiring to be the "most perfect mechanic of all"! And, in fact, Hume makes sure we know this is what he has in mind with his oblique reference to "a mechanic" in the following passage, which appears at the end of his argument on the subject: **(p. 688)**

> We are sensible, that the addition or removal of one of these minute [microscopic] parts, is not discernable either in the appearance or measuring… . [W] e therefore suppose some imaginary standard of equality, by which the appearances and measuring are exactly corrected… . [But] the notion of any correction beyond what we have instruments and art to make, is a mere fiction of the mind… . [Thus a] musician finding his ear become every day more delicate, and correcting himself by reflection and attention, proceeds with the same act of mind, even when the subject fails him, and entertains the notion of a compleat *tierce* or *octave,* without being able to tell whence he derives his standard. A painter forms the same fiction with regard to colours. A mechanic with regard to motion. To the one *light* and *shade;* to the other *swift* and *slow* are imagin'd to be capable of an

> exact comparison and equality beyond the judgments of the senses. (T 1.2.4.24/48–9; emphasis in the original)

The “mechanic” here is again almost certainly Newton, the application of geometry to mechanics being the signature achievement of Newton’s *Principia*. And Newton’s belief that he can judge two velocities equal to greater than a certain degree of precision is here called “a mere fiction of the mind.” Indeed, Hume here mischievously compares Newton’s supposedly exact science to the level of precision expected of an accomplished musician or painter.[55] Newtonian science is, like the geometry on which it is based, no better than an “art.”[56]

II.3 The Universality of the Law of Gravitation

Earlier analyses of Hume’s attack on Newton in *Treatise* 1.3 have focused on Hume’s criticism of the Newtonian conception of causation, on Hume’s rejection of Rule IV of Newton’s “Rules for the Study of Natural Philosophy,” and on Hume’s treatment of the Newtonian category of *force*. [57] In this section, we discuss what we take to be another central aspect of Hume’s criticism of Newton. This is Hume’s attack on Rule III of Newton’s rules for studying philosophy—which is the rule that underwrites Newton’s claim that his Law of Gravitation is universal in character.[58]

Newton’s Rule III stipulates that a quality observed to hold good for all bodies subject to experimental observation is to be ascribed to all bodies in the universe. As he writes:

> Those qualities of bodies that cannot be intended and remitted [i.e., added and removed] and that belong to all bodies on which experiments can be made should be taken as qualities of all bodies universally. (1687: 795)

Thus, on Newton’s view, we can tell that all objects in the universe, including microscopic objects and distant celestial bodies “beyond the range of our senses,” are “extended, hard, impenetrable, movable, and endowed with force of inertia” because all objects that are within the reach of our experiments possess these properties.[59] This assumption of universality for properties that are always and everywhere observed is, for Newton, nothing less than “the foundation of all of natural philosophy,” and, having established it in (p. 689) principle with regard to the essential qualities of matter,[60] Newton goes on to apply it to gravitation as well, concluding on the basis of the observations in the *Principia* that all bodies in the universe gravitate toward one another.[61] It is emblematic of what Hume, in the *History,* refers to as Newton’s quality of being “resolute to adopt every … principle” derived from careful observation, “however new or unusual” (HE VI 542).

In the *Treatise,* Hume follows Newton's example by providing his own rules of philosophical reasoning, which he calls "Rules by which to judge of causes and effects." Indeed, Hume says that these rules are "all the *logic* I think proper to employ in my reasoning" (T 1.3.15.11/173–5).[62] But Hume's rules of reasoning depart from Newton's in a number of ways,[63] of which the most glaring is the absence in Hume's discussion of anything parallel to the *Principia*'s Rule III. Since it is Rule III that establishes a criterion for determining which observed properties can be said to apply universally, the absence of such a rule of reasoning immediately deprives Newtonian gravitation of its status as a genuinely "*Universal* Law of Gravitation."

But Hume does not stop at just editing out the Newtonian rule that permits gravity to be seen as a universal property of matter. His "Rules by which to judge of causes and effects" include an oblique treatment of Newtonian universal gravitation in the form of Hume's Rule VII, which reads as follows:

> When any object encreases or diminishes with the encrease or diminution of its cause, 'tis to be regarded as a compounded effect, deriv'd from the union of the several different effects, which arise from the several different parts of the cause. The absence or presence of one part of the cause is here suppos'd to be always attended with the absence or presence of a proportionable part of the effect.… . We must, however, beware not to draw such a conclusion from a few experiments. A certain degree of heat gives pleasure; if you diminish that heat, the pleasure diminishes; but it does not follow, that if you augment it beyond a certain degree, the pleasure will likewise augment; for we find that it degenerates into pain. (T 1.3.15.9/174)

The relationship between Hume's Rule VII and Newtonian gravitation, which is not explicit in his text, is established by Hume's wording, which closely follows Newton's phrasing in discussing gravity in the *Principia:* [64] In his Book 3, Proposition 7, Corollary 1, Newton describes gravitation as an action in which "every attraction toward a whole arises from the attractions toward the individual parts."[65] In Rule VII, Hume speaks in these same terms, arguing that a quality that "encreases or diminishes with the encrease or diminution of its cause," should be "regarded as a compounded effect, deriv'd from the union of the several different effects, which arise from the several different parts of the cause." And, elsewhere in the *Treatise,* Hume writes explicitly of the force of gravitation using just this language.[66] On the face of it, then, Hume's Rule VII seems to adopt Newtonian language in order to provide an alternative description of the kind of extrapolation involved in establishing Newtonian gravitation.

But only the first half of Rule VII is compatible with Newton's science. In the latter half, Hume turns against Newton, warning against the attempt to "draw such a (p. 690) conclusion from a few experiments." Indeed, we know quite well that effects can vary proportionately within a certain range of experience and yet behave completely differently outside of this range. Hume gives the example of our experience of fire. A "certain degree of heat gives pleasure; if you diminish that heat, the pleasure diminishes; but it does not follow, that if you augment it beyond a certain degree, the pleasure will likewise augment; for we find that it degenerates into pain." This argument, made with respect to heat, is no less applicable to the Newtonian force of gravitation: what appears to be a strictly proportional relation over a given range of experience can turn into something quite different when one strays from this range.

What we have, therefore, is as follows. Newton's Rule III, which is the basis for the claimed universality for his law of gravitation, is met and replaced by Hume's Rule VII, whose intent is in a certain sense precisely the opposite: The so-called universal law of gravitation must be regarded only as characterizing a certain range of human experience and no more.[67] Extension of this law beyond our experience, whether into the heavens or the microworld, cannot be admitted into science (except as "hypothesis"). And the same will have to be said for all other qualities that are attributed to bodies significantly outside of the bounds of our actual experience. What to Newton is nothing less than the "foundation of all natural philosophy"—his Rule III—is in Hume's philosophy shown to be unnecessary for scientific reasoning and of questionable validity.[68]

II.4 The Mind-Independence of Forces

To this point, we have discussed three aspects of Hume's attack on Newton that together challenge the *Principia*'s aspirations to attain fundamental, certain, and universal knowledge. These criticisms broadly fit within the view of Hume as seeking to use psychological science to establish the proper bounds for the sciences.[69] But at least one facet of Hume's attack on Newton in *Treatise* I, Book 3 seems to be much too far-reaching to be considered an exercise in bounds-setting for the sciences: Hume's analysis of the Newtonian category of *force*, the fundamental explanatory concept in the *Principia*.[70] In this section, we argue that what Hume wants to show is that forces are, like necessary connection, an aspect of reality that is *mind-dependent.*

No physical category is as significant to the Newtonian project as that of force: in the preface to the *Principia,* Newton extrapolates from his successful analysis of the mechanical movements of objects, proposing that perhaps *all* natural phenomena may be reducible to forces of attraction and repulsion. As he writes:

> [T] he basic problem of philosophy seems to be to discover the forces of nature from the phenomena of motions and then to demonstrate the other phenomena from these forces… . If only we could derive the other phenomena of nature from mechanical principles by the same kind of reasoning! For many things lead me to have a suspicion that all phenomena may depend on certain forces by which the (p. 691) particles of bodies … either are impelled toward one another … or are repelled from one another. (1687: 382–383)

Thus, it is particularly important to notice that the Newtonian category of force is one of the principal targets of Hume's discussion in *Treatise* I, section 3.14, which is usually read only as a treatment of necessary connection.[71] That Hume's subject here is the physical category of force (and its twin, power) is easily missed because these terms are mixed together with references to necessary connection to such an extent that the two terms appear as though they are intended to be indistinguishable from one another.[72] Indeed, Hume says explicitly that these terms are "nearly synonimous":

> [T] he terms of *efficacy, agency, power, force, energy, necessity, connexion, and productive quality, are all nearly synonimous.* (T 1.3.14.4/157; emphasis in original)

It is not our intention to challenge the view that, for Hume, *force* and *necessity* are abstracted together in such a way that the two terms refer to more or less the same thing. Nevertheless, we do want to draw attention to the fact, often overlooked, that at certain junctures in his discussion, Hume carefully distinguishes force from necessity—not to establish them as distinct philosophical concepts, but because he wants to make sure he is understood as mounting a critique of the category of power or force no less than that of necessary connection. This occurs for the first time in the following passage:

> [W] hen we talk of any being, whether of a superior or inferior nature, as *endow'd with a power or force, proportion'd to any effect;* when we speak of a necessary connexion betwixt objects, and suppose, that this connexion depends upon an efficacy or energy, with which any of these objects are endow'd; in all these expressions, so apply'd, we have really no distinct meaning, and make use only of common words, without any clear and determinate ideas. (T 1.3.14.14/162; emphasis added; emphasis removed from "so apply'd.")

In this passage, Hume is making a single argument, but he carefully applies it to what he knows his readers might otherwise understand as two separate subjects: (1) "any being … endow'd with a power or force, proportion'd to any effect"[73] and (2) "a necessary connexion betwixt objects." The first of these subjects is plainly intended to include Newton's use of the category of force in the *Principia*: Newton's Second Law of Motion

stipulates that *"A change in motion is proportional to the motive force impressed"* (1687: 416), which is to say that, in Newtonian science, an object is paradigmatically endowed with a force proportioned to a given effect (i.e., its "change in motion")—which is precisely what Hume is here referring to.[74] This means that Hume here draws a clear parallel between Newtonian force and the second category he names, that of "a necessary connexion betwixt objects." Indeed, after this first passage, Hume's subsequent discussion refers to "power and necessity" in parallel time and again—by our count, ten (p. 692) times[75]—to signal that each of these categories is still being treated (and at the same time to encourage readers to bring them together in a single conception).

Because Hume conducts his discussion of power and force concurrently with his discussion of necessity, it is not surprising that what he says about forces is quite similar to what he says about necessity: The respective appearances of objects include qualities such as color, shape, and texture, but they possess no quality that could permit one object to exert an influence on another. As far as the reports of sensation are concerned, then, there is no such thing as a force.[76] The question is where our knowledge of things in the category of force or power comes from.

Hume's solution is to understand forces as added to objects by the mind of the human observer. What is perceived is pairs of objects appearing together repeatedly in accordance with a certain time order, and this repetition brings about the *imposition* of a force on the objects—an imposition whose source is not in the objects themselves but in our minds. As Hume writes:

> Tho' the several resembling instances, which give rise to the idea of power, have no influence on each other, and can never produce any new quality *in the object,* which can be the model of that idea, yet the *observation* of this resemblance produces a new impression *in the mind,* which is its real model. For after we have observ'd the resemblance in a sufficient number of instances, we immediately feel a determination of the mind to pass from one object to its usual attendant… . The several instances of resembling conjunctions leads us into the notion of *power and necessity.* These instances are in themselves totally distinct from each other, and have no union but in the mind, which observes them, and collects their ideas. (T 1.3.14.20/164–5; emphasis added to "power and necessity.")

With this in mind, consider, for example, the crucial "moon test" at Proposition 4 of Book III of the *Principia*, in which Newton identifies the centripetal force maintaining the moon in its orbit with terrestrial gravity. In this passage, Newton considers what the acceleration of the moon would be if it were brought to near the earth's surface, as

calculated from orbital acceleration in conjunction with the inverse-square variation in the centripetal force. This turns out to be very nearly the acceleration of terrestrial bodies due to gravity, as measured by Huygens, permitting Newton to invoke his first and second "Rules for the Study of Natural Philosophy" to conclude that the two forces should be identified as a single force.[77] On Hume's view, however, no force of the earth acting on the moon is detected by the senses. If there had been anything there to be sensed, the gravitational pull of Earth on the moon would have been recognized millennia earlier. It was not until Newton "plac'd on the body"[78] of the earth such a power or force, by means of an operation of his own mind, that there was, strictly speaking, anything there to be detected. Hume's conclusion is that such a force is not part of the "operations of nature" if these are understood as being "independent of our thought and reasoning."[79] Power or force, like necessary connection, is drawn "from what we feel internally" in observing the objects of nature: (p. 693)

> [W] e are led astray by a false philosophy … when we transfer the determination of the thought to external objects, and suppose any real intelligible connexion betwixt them; that being a quality, which can only belong to the mind that considers them… . [I]f we go any farther, and ascribe a *power or necessary connexion* to these objects; this is what we can never observe in them, but must draw the idea of it from what we feel internally in contemplating them. (T 1.3.14.27/168–9; emphasis added to "power or necessary connexion.")

With respect to Newtonian forces, then, Hume's view is unequivocal: The forces of attraction and repulsion, to which Newton proposes that we reduce all natural phenomena, are for Hume something that "can only belong to the mind that considers them."

III Conclusion

Hume was in important respects a Newtonian. His project in the *Treatise* was probably the most sophisticated attempt to apply the method of the *Principia*—Newton's method of analysis and synthesis—to the study of the human mind.[80] And although psychological science has moved in other directions, even today the attempt to understand the human mind in terms of general cognitive laws or mechanisms as proposed by Hume is occasionally recognized as a live possibility.

Yet Hume was also troubled by the growing influence of Newtonian ideas. Newton's thought was overtly religious and explicitly encouraged doctrines that Hume might have wished to see set aside.[81] But, more than this, Hume saw the science of the *Principia,*

with its bold assertions of having attained fundamental, certain, and universal knowledge, as contributing to an ongoing willingness on the part of scholars and laymen to accept hypothesis as principle and principle as doctrine. What Hume regarded as a chronic lack of scientific caution on the part of Newton and his followers led, among other things, to Hume's attacks in the *Treatise* on Newton's advocacy of absolute space and time and claims regarding the infallibility of geometry, as well as on Newton's Rules for the Study of Philosophy, which underwrite the claim of universality for the law of gravitation. Most intriguing of all, Book 1 of Hume's *Treatise* insists that the central category introduced in the *Principia* as the proposed basis for all of natural science, that of force, refers to qualities of objects that are mind-dependent and thus ultimately rooted in human psychology.

That Hume's criticism of Newtonian science has been difficult for later readers to recognize is no surprise. Newtonian ways of thinking were so completely victorious in natural science for so long that Hume's critique may still seem to us to have been quixotic. But, in light of the considerations mustered here, it may be worth revisiting, for example, Einstein's own reports of Hume's influence on the theory of relativity—a development in physical science that becomes possible only after the abandonment of absolute space and time.[82] We are not accustomed to thinking that, on certain issues, Hume may have (p. 694) seen farther than Newton concerning the nature of science and reality. But Hume's critique of Newton was a powerful one. And, as the history of science unfolds, the validity of aspects of Hume's challenge to Newton may receive greater recognition.

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Notes:

(1.) This implies that, on some level, Hume accepts the claim of the proponents of the mechanical philosophy that theirs is the only approach that could have made nature truly intelligible.

(2.) Clarke is quoting Ecclesiasticus 43: 32–33 from the King James edition.

(3.) For a discussion understanding Hume as responding to Clarke and focally concerned with an attack on religion and Christianity, see Russell (2008). For further background see Schliesser (2012).

(4.) The classic formulation of this view is in Kemp Smith (1941/2005). A similar approach is followed by Laird (1932/1967), Capaldi (1967), Stroud (1977), Pears (1990), Flage (1990: 6–18), Biro (1993), McDowell (1998), Loptson (1998: 317–8), Macarthur (2004), Millican (2007: x). A different but related view of Hume as an "arch-naturalist" is presented in Strawson (1985: 1–29). This phrase is on p. 3.

(5.) See Waxman (1996), Schliesser (2007; 2008; 2009; 2015), Boehm (2008; 2012), Hazony (2009; 2014).

(6.) See Shank (2008).

(7.) But even Berkeley had toned down his criticism of Newton between the first and second editions of his *Principles*.

(8.) Newtons' best-known discussion of analysis and synthesis is in Query 31, published at the end of the Second Edition of the *Opticks* in 1717. There, Newton describes the derivation of forces of nature from the phenomena "by induction" as follows: "By this way of analysis we may proceed from compounds to ingredients, and from motions to the forces producing them; and in general from effects to their causes, and from particular causes to more general ones, till the argument end in the most general." (Newton 1740: 404). Newton already describes this method, although without using these terms, in the preface to the First Edition of the *Principia,* where he writes that "the basic problem of philosophy seems to be [i] to discover the forces of nature from the phenomena of motions and then [ii] to demonstrate the other phenomena from these forces" (Newton 1687: 382). For further discussion, see Cotes's introduction to the Second Edition of the *Principia* (1713: 386), Guicciardini (2009), Ducheyne (2012), and Hazony (2014). Note that while Newton's use of the term "induction" is distinctive from a modern perspective, Newtonian induction closely resembles Hume's description of the aim of philosophy in the *Treatise* and *Enquiries* (Hazony 2014).

(9.) The structure of the *Principia* is, in fact, more complex than this. The law of gravitation cannot be derived from the laws of motion alone, and Newton introduces a second induction from the phenomena at the beginning of Book III. See Guicciardini (2009: 322–323), Ducheyne (2005: 73–75).

(10.) See, for example, TA 1/646; EU 4.1.5/30. For further discussion, see Demeter (2012), Hazony (2014).

(11.) Scholars who do take notice of this expression include Norton (1993: 6–7), Norton (2000: I–16), Waxman (1994: 25f), Waxman (1996: 124, 152n), Allison (2008: 13f). Although David Owen doesn't comment on this expression, his treatment of the elements in this part of the *Treatise* as "fundamental explanatory principles" that are to be used "in an explanation of … more derivative phenomena" is similar to the view we are presenting here (Owen 1999: 150).

(12.) Our list is therefore somewhat more extensive than that of Owen (1999: 150) who counts Hume's "fundamental explanatory principles" as "the distinction between impressions and ideas in terms of force and vivacity, and the three principles of association." But we and Owen are in agreement that Hume's aim is simplicity and also roughly on the content of Hume's elements. A very different approach is that of Waxman

(1994: 25), whose far more extensive list of items or “elements” includes close to two dozen of them. Waxman is right that Hume’s philosophy cannot be understood without a thorough understanding of all of these terms from Book 1, Part 1. But he ignores Hume’s claim that his aim is to discover “the simplest and fewest causes” of the phenomena he treats. Waxman therefore misses the fact that his list includes many items that can be reduced to other items, as well as items that are descriptions of other items, so that Hume’s broader reductive purpose is lost.

(13.) Impressions are of two kinds, *impressions of sensation* and *impressions of reflection*. Impressions of this second kind “are the passions, and other emotions resembling them” (T 2.1.1.1/275; cf. T 1.1.6.1/16). But the second kind also turns out to serve as the subconscious basis for qualities of objects that are not reported by the senses, such as the property of being a *cause* or of being *real*. This means that, in Hume’s theory, the mind brings its own contribution to the construction of the world. See Mounce (1999), Rocknak (2013).

(14.) Hume seems to admit that copies may be made of copies (T 1.1.2/8). The relatively strong original copies constitute *memory*, whose purpose is to “preserve the original form, in which its objects were presented,” as well as “their order and position,” whereas derivative copies are used in *imagination* and are even weaker (T 1.1.3.1/8–9). Compare: “Our imagination has a great authority over our ideas; and there are no ideas that are different from each other, which it cannot separate and join, and compose into all the varieties of fiction” (TA 35/662).

(15.) See further discussion in Section I.2 herein.

(16.) Hume’s method obviously diverges from Newton’s in that Newton seeks geometric proofs to demonstrate that the phenomena can be deduced from the causes he has discovered.

(17.) “Here therefore I must ask: *What is our idea of a simple and indivisible point?* No wonder if my answer appear somewhat new, since the question itself has scarce yet ever been thought of. We are wont to dispute concerning the nature of mathematical points, but seldom concerning the nature of their ideas” (T 1.2.3.14/38).

(18.) On this point, see Schaffer (2003: 498–517).

(19.) Even in the case of substance, Hume is ambigious. He allows that each perception may well be thought of as substance (T 1.4.5.5/233).

(20.) See also T 1.3.14.13/161.

(21.) These sidelined ideas are what Don Garrett (1997: 24) has called the “revival set” associated with the term in question.

(22.) Because actually bringing to mind “all the ideas, to which the name may be apply’d, is in most cases impossible, we abridge that work by a more partial consideration, and find but few inconveniences to arise in our reasoning from that abridgment” (T 1.1.7.7/21). Also: “All abstract ideas are *nothing but* particular ones, consider’d in a certain light; but being annexed to general terms, they are able to represent a vast variety, and to comprehend objects, which, as they are alike in some particulars, in other ways are vastly wide of each other” (T 1.2.3.5/34; emphasis added).

(23.) Emphasis added to *nothing but.* Compare T 1.4.7.5/266.

(24.) Although he does allow, sarcastically, that he is willing to exempt from this reductive description “some metaphysicians” who may be different from himself and the rest of mankind in this respect (T 1.4.6.4/252).

(25.) See Sturm (2014) for a broader overview of eighteenth-century uses of the method of analysis and synthesis.

(26.) Hume also insisted that in astronomy this explanatory reductionism is the achievement of Copernicus (T 2.1.3.7/282). For more on this issue, see Schliesser (2010).

(27.) See Kallich (1945).

(28.) See Newton (1726: 943).

(29.) See Schliesser (2004).

(30.) Space and time enjoy no comparably prominent treatment in Descartes or Locke, so Hume’s placement of this subject at the very front of the *Treatise* (whereas Locke, for example, began with his attack on innate ideas) can be taken as a strong indication of the importance Hume ascribed to Newtonian philosophy.

(31.) On Hume’s attack on the Newtonian idea of the vacuum, see Garrett (1997: 56–5), Boehm (2008: 91–100; 2012). On Newtonian absolute time, see Boehm (2008: 100–6) and Schliesser (2013).

(32.) For Berkeley’s critique of Newton, see Berkeley (1721; 1734; 1735). See also, especially, Jesseph (2010), Guicciardini (1989).

(33.) See Boehm (2008: 100–106).

(34.) These “[r] elative qualities … are not the actual quantities whose names they bear but are those sensible measures of them … that are commonly used instead of the [absolute] quantities being measured” (Newton, 1687: 414). Compare: “[M]otion and rest, in the popular sense of these terms, are distinguished from each other only by point of view, and bodies commonly regarded as being at rest are not always truly at rest” (Newton, 1687: 405). This amounts to a defense of the possibility of absolute rest and motion, apparently as against Descartes’s insistence that these were relative terms (Westfall 1971/1977: 126).

(35.) “Although time, space, place, and motion are very familiar to everyone, it must be noted that these quantities are properly conceived solely with reference to the objects of sense perception. And this is the source of certain preconceptions; to eliminate them it is useful to distinguish these quantities into absolute and relative, true and apparent… . 1. Absolute, true and mathematical time, *in and of itself and of its own nature, without reference to anything external,* flows uniformly… . Relative, apparent, and common time is any sensible and external measure … ; such a measure—for example, an hour, a day, a month, a year—is commonly used instead of true time. 2. Absolute space, *of its own nature without reference to anything external,* always remains homogenous and immovable. Relative space … is determined by our senses from the situation of the space with respect to bodies and is popularly used for immovable space… . [F] or primary places to move is absurd… . But since these [absolute] parts of space cannot be seen and cannot be distinguished from one another by our senses, we use sensible measures instead” (Newton 1687: 408–410; emphasis added). Newton is clear that our usual, nontechnical understanding of space and time is that which is derived from the experience of our senses, for “if the meanings of words are defined by usage, then it is these sensible measures which should properly be understood by the terms ‘time,’ ‘space,’ ‘place,’ and ‘motion’ ” (1687: 413–414).

(36.) As Newton writes in the Scholium at the beginning of the *Principia,* detecting the effects of absolute space and time is “very difficult” but “not entirely hopeless”: “[I] t is certainly very difficult to find out the true motions of individual bodies and actually to differentiate them from apparent motions, because the parts of that immovable space in which the bodies truly move make no impression on the senses. Nevertheless the case is not entirely hopeless. For it possible to draw evidence partly from apparent motions, and partly from the causes and effects of the true motions… . [I]n what follows, a fuller explanation will be given of how to determine true motions… . For this was the purpose for which I composed the following treatise” (1687: 414–415). This is an extraordinary claim—with Newton asserting that to teach his readers how to detect absolute space and time was nothing less than the “purpose” for which the whole *Principia* was written. See Stein (2002), di Salle (2002), Smeenk and Schliesser (2013). See also Schliesser (2013).

(37.) The “immobile point” that is the center of the universe in the *Principia* appears, as Newton is well aware, as an unsubstantiated hypothesis—although Newton unhelpfully writes that “No one doubts this” (1687: 816–817). Compare: “[I] t is possible that there is no body truly at rest to which places and motions may be referred” (1687: 411). To be clear, Corrolaries 5 and 6 to the Laws of Motion imply that Newton is treating the fixed stars as akin to an inertial frame.

(38.) In particular, it is crucial to Newton’s enterprise that he can identify “absolute accelerations.” But absolute velocities and positions are not required for this. See Corrolary 5. We thank Chris Smeenk for discussion.

(39.) Hume writes: “The table before me is alone sufficient by its view to give me the idea of extension. This idea, then, is borrow’d from … some impression, which this moment appears to the senses. But my senses convey to me only the impressions of colour’d points, dispos’d in a certain manner. If … it be impossible to shew any thing farther, we may conclude with certainty, that the idea of extension is nothing but a copy of these colour’d points, and of the manner of their appearance… . [A] fterwards having experience of the other colours … , we omit the peculiarities of colour, as far as possible, and found an abstract idea merely on that disposition of points, or manner of appearance, in which they agree” (T 1.2.3.4/34).

(40.) See, more generally, T 1.2.3.6–10/34–7: “The idea of time, being deriv’d from the succession of our perceptions of every kind, ideas as well as impressions … will afford us an instance of an abstract idea, which comprehends a still greater variety [of objects] than that of space, and yet is represented in the fancy by some particular individual idea… . Five notes played on the flute give us the impression and idea of time; tho’ time be not a sixth impression, which presents itself to hearing or any other of the senses… . [S] ince [time] appears not as any primary distinct impression, [it] can plainly be nothing but different ideas, or impressions, or objects dispos’d in a certain manner, that is, succeeding each other.”

(41.) See our discussion of Hume’s reduction of the concept of an abstract idea in Section I.1.

(42.) This passage is particularly written about the possibility of conceiving of “time without changeable existence,” which is to say, time as it is in itself in the absence of perceptible changes in the appearances, or absolute time. The argument is identical to Hume’s argument against absolute space.

(43.) Such tacit attacks were commonplace in Hume’s time. Thanks to Moti Feingold for discussion of this point. On Newton’s complex embrace and reinterpretation of mechanical philosophy, see Kochiras (2013).

(44.) Interestingly, in a manuscript now the subject of considerable scholarly attention but unknown in Hume's time, *De Graviatione*, when Newton offers a probable account of the nature of "body," he insists that one of its essential qualities is to be able to "excite various perceptions of the senses and the imagination in created minds, and conversely be moved by them" (pre-1695: 28–29).

(45.) That is, Hume has been dealing with questions such as "the cause, which separates bodies [from one another], and gives them the capacity of receiving others betwixt them" (T 1.2.4.25/63–4). Thus, while referring to the qualities of bodies, he is in fact continuing his discussion of space and time. The Appendix to the *Treatise* also provides evidence for our strategy of treating Hume's argument on the vacuum, space, time, and body as intrinsically connected (T 1.2.5 n12.2/639).

(46.) Compare this with Newton's view as presented in the General Scholium to the second edition, in which he writes that "[W] e certainly do not know what is the substance of any thing. We see only the shapes and colors of bodies, we hear only their sounds, we touch only their external surfaces, we smell only their odors, and we taste their flavors. But there is no direct sense and there are no indirect reflected actions by which we know innermost substances" (1687: 942).

(47.) A second conclusion to Hume's argument concerning space and time is a brief section appended to the end of Book 1, part 2, entitled *Of the idea of existence, and of external existence,* in which Hume takes a parting shot at philosophers such as Newton who imagine that their reason can carry them beyond what is "present to the mind" and out "to the heavens, or to the utmost limits of the universe." To these, he writes: "[S] ince nothing is ever present to the mind but perceptions, and since all ideas are derived from something antecedently present to the mind; it follows, that 'tis impossible for us so much as to conceive or form an idea of any thing specifically different from ideas and impressions. Let us fix our attention out of ourselves as much as possible. Let us chace our imagination to the heavens, or to the utmost limits of the universe; we never really advance a step beyond ourselves; nor can conceive any kind of existence, but those perceptions, which have appear'd in that narrow compass" (T 1.2.6.8:67–8).

(48.) "A New Theory About Light and Colors" (1672), quoted in Shapiro (1993: 21). This aim of constructing a science of rigid consequences capable of eliminating any suspicion of doubt sounds, to our ears, more Scholastic or Cartesian than something characteristic of empirical science. Yet Newton's interest in rebuilding natural philosophy on a mathematical basis is in fact aimed at attaining something very much akin to the Scholastic and Cartesian dream of *scientia,* knowledge free from doubt. Newton's concern is to "extend the bounds of mathematics," thus enabling the method of

demonstrative proof to penetrate the realm of “physical things.” From Newton’s *Optical Papers*, quoted in Shapiro (1993: 25).

(49.) As Christopher Wren told his students in 1657: “Mathematical demonstrations being built on the impregnable foundations of geometry and arithmetick, are the only truths, that can sink into the mind of man, *void of all uncertainty;* and all other discourses participate more or less of truth, according as their subjects are more or less capable of mathematical demonstration. Therefore, this rather than logick is the … [basis for] all infallible science” (from Wren’s inaugural lecture as professor of astronomy at Gresham College, as quoted in Shapiro [1993: 31]; emphasis added).

(50.) “[T] he whole subject of *mechanics* is distinguished from *geometry* by the attribution of exactness to geometry and of anything less than exactness to *mechanics*. Yet the errors do not come from the art, but from those who practice the art. Anyone who works with less exactness is a more imperfect mechanic, and if anyone could work with the greatest exactness, he would be the most perfect mechanic of all” (Newton 1687: 381–382).

(51.) Note that the claim that Hume’s supposed inability to understand the mathematics of the *Principia* is apparently a myth. See Barfoot (1990).

(52.) He continues: “[N] or would it err at all, did it not aspire to such an absolute perfection.”

(53.) “[G] eometry, or the art, by which we fix the proportions of figures; tho’ it much excels both in universality and exactness, the loose judgments of the senses and imagination; yet never attains a perfect precision and exactness. Its first principles are still drawn from the general appearance of the objects; and that appearance can never afford us any security, when we examine, the prodigious minuteness of which nature is susceptible” (T 1.3.1.4/70–1).

(54.) For Hume’s further use of this argument in his critique of matter, see Rocknak (2013: 119–20). Space constraints prevent us from exploring Hume’s other more general argument(s) against the applicability of mathematics at *Treatise* 1.4.1–2. See Meeker (2007).

(55.) Hume speaks of the “art of measuring” at T 1.2.4.24/48, an expression that echoes Newton (1687: 382). But Newton speaks of “reducing the art of measuring to exact propositions and demonstrations.” For Hume there is no such reduction to exactness, and measuring remains an art. Geometry itself, Hume affirms at T 1.3.1.4/70, is an “art.”

(56.) Although Hume and Newton share an empiricism about geometry, it may be argued that Hume's argument is less compelling than he may have thought. First, Newton explicitly relies on *quam-proxime* reasoning. Second, what really matters for Newton is whether his conceptual apparatus is precise enough for the purposes of theory-mediated measurement. It is not clear that Hume appreciated either point fully (see Smith 2001). Third, Hume never offers an example of where the inferential uses of Newton's fluxional geometry is not up to its assigned task.

(57.) On Newton's Rule IV, see Schliesser (2009: 186–189); and on forces, see Schliesser (2009 195–198). On causation, see Schliesser (2009: 191–195), as well as Schliesser (2008).

(58.) The ability to determine the essential qualities of matter is what licenses Newton's ability to extrapolate from our experience to universal laws of physics such as gravitation. See McGuire (1968; 1970). In particular, Newton believes he can experimentally secure claims about the additive composition of matter with an empirical criterion for asserting what is essential to systems of matter (Belkind 2012). Hume does not believe that any such criterion for distinguishing essential qualities of matter exists. Moreover, in Roger Cotes's influential presentation of these matters in his Editor's Preface to the Second Edition of the *Principia*, Newton is presented as applying a version of the distinction between primary and secondary qualities (Cotes 1713), which is the subject of Hume's attack on the "modern philosophy" in T 1.4.4. Hume's rejection of Rule III must therefore be seen as thoroughgoing and allowing no compromises. It is at the heart of Hume's attack on Newton.

(59.) As Newton writes: "[T] he qualities of bodies can be known only through experiments; and therefore qualities that square with experiments universally are to be regarded as universal qualities… . [N]ature is always simple and consonant with itself. The extension of bodies is known to us only through our senses, and yet there are bodies beyond the range of these senses; but because extension is found in all sensible bodies, it is ascribed to all bodies universally" (1687: 795).

(60.) "The extension, hardness, impenetrability, mobility, and force of intertia of the whole [sensible object] arise from the extension, hardness, impenetrability, mobility, and force of intertia *of each of the parts*; and thus we conclude that every one of the least parts of all bodies is extended, hard, impenetrable, movable, and endowed with force of intertia. And this is the foundation of all natural philosophy" (1687: 795–796; emphasis added). Compare this to the magnetic force, which "in one and the same body can be intended or remitted … " (1687: 810; i.e., Book 3, Prop. 6, Corollary 5). Note that the compositionality claim is taken to be foundational. See Belkind (2012) for interesting discussion.

(61.) “Finally, if it is universally established by experiments and astronomical observations that all bodies on or near the earth gravitate toward the earth, and do so in proportion to the quantity of matter in each body, and that the moon gravitates toward the earth in proportion to the quantity of its matter, and that our sea in turn gravitates toward the moon, and that all planets gravitate toward one another, and that there is a similar gravity of comets toward the sun, it will have to be concluded by this third rule that all bodies gravitate toward one another” (1687: 796; translator’s interpolation removed). In this way, Newton’s rule functions as the engine for transforming what would otherwise be a science of systematized local observations into one that presents truths that are “by Rule III … to be affirmed of all bodies universally” (1687: 809; i.e., Book 3, Prop. 6, Cor. 2).

(62.) Hume’s “logic” is a logic of establishing the causes of things. This is the equivalent of Newton’s “method of analysis.” In this use of the term “logic,” Hume follows the traditional definition of logic as “the art of thinking justly” (see Chambers, *Cyclopedia*).

(63.) See Schliesser (2007), sect. 4.5.

(64.) It is significant that Hume declines to follow Newton’s concept of a quality that “cannot be intended and remitted,” which he apparently rejects: Newton’s Rule III is about a certain kind of quality. Newton has in mind qualities such as extension, solidity, inertia, and gravity, which, he believes, may be distinguished from other qualities of objects by the fact that they “cannot be intended and remitted.” By this, Newton means that qualities of this type cannot be removed from objects that possess them: that is, there is nothing that can be done to an extended object such that it will cease to be extended or to a gravitating object such that it will cease to gravitate. (For discussion, see Ducheyne 2012: 115–8). Hume, on the other hand, declines to discuss qualities that “cannot be intended and remitted,” and although he nowhere gives a reason for this omission, we suspect it is because Hume does not believe there is a way to know whether a given quality is such that it “cannot be intended or remitted.” Hume is fond of saying that “whatever we [can] conceive is possible” (T 1.4.5.10/236). Similarly: “Any thing may produce any thing. Creation, annihilation, motion, reason, volition; all these may arise from one another, or from any other object we can imagine” (T 1.3.15.1/173). And there is little that is more easily conceived than that something possessing hardness or gravity should cease to have these qualities.

(65.) This is because “the force of the whole will have to arise from the forces of the component parts” (1687: 811; i.e., Book 3, Prop. 7, Cor. 1). See Belkind, op cit.

(66.) “We may establish it as a certain maxim, that in all moral as well as natural phaenomena, wherever any cause consists of a number of parts, and the effect encreases

or diminishes, according to the variation of that number, the effects properly speaking, is a compounded one, and arises from the union of the several effects, that proceed from each part of the cause. Thus, because the gravity of a body encreases or diminishes by the encrease or diminution of its parts, we conclude that each part contains this quality and contributes to the gravity of the whole. The absence or presence of a part of the cause is attended with that of a proportionable part of the effect. This connexion or constant conjunction sufficiently proves the one part to be the cause of the other" (T 1.3.2.16/136).

(67.) This anticipates Nancy Cartwright's criticism of physical law, for example in Cartwright (1983).

(68.) The view we have presented here is at odds with that of Graciela de Pierris, who builds her discussion of Hume's debt to Newton around Hume's putative embrace of Newton's Rule III as the cornerstone for his philosophical method (de Pierris 2006: 306–10, 312). De Pierris bases this conclusion on two controversial assumptions: (1) that Newton's Rule III provides a general instrument for extending inductive inferences from one observed phenomenon to another, and from locally observed phenomena to the entire universe of possible phenomena; and (2) that Hume follows Newton in accepting the possibility of extracting genuinely universal laws from the observation of local phenomena. Regarding (1), de Pierris ignores the fact that Newton's Rule III is explicitly written with reference *only to a very specific kind of quality,* namely, "[t] hose qualities of bodies that cannot be intended and remitted and that belong to all bodies on which experiments can be made." The universally observed presence of such essential qualities as extension and hardness, and of nonessential but nonremittable qualities such as gravitation (nonessential because, in principle, a body can be a body without the quality of gravity), is thus said to license the supposition that such qualities are present in all bodies in the universe. Nowhere does Newton hint, as de Pierris suggests, that this rule of universalization can be applied to anything other than such essential or quasi-essential qualities of physical bodies. Regarding (2), we have found no instance in Hume's writings in which he concedes to Newton the notion that we can know anything to be "either exactly or very nearly true" about the microworld or the ends of the universe on the basis of local experiments. Hume does constantly use the word "universal" to refer to things that always happen *in our experience*. But nowhere does Hume endorse the Newtonian idea that there are things that can be known concerning the qualities of "all bodies universally" on the basis of our local experience.

In arguing for Hume's endorsement of Rule III, de Pierris points to one passage in which she believes this endorsement is almost explicit. This is a comment of Hume's in *An Equiry Concerning the Principles of Morals*, Section 3, in which he argues that since "public interest and utility" is the cause of "esteem or moral approbation" in the case of

justice, it should also be considered the cause of such esteem and approbation with respect to virtues such as “humanity, benevolence, friendship, public spirit,” and others. Having proposed a like cause (public interest and utility) for like effects (esteem or moral approbation for virtues such as humanity, etc.), Hume then comments: “It is entirely agreeable to the rules of philosophy … , where any principle has been found to have great force and energy in one instance, to ascribe to it a like energy in all similar instances. This indeed is Newton’s chief rule of philosophizing” (EM 3.48/204). Hume’s footnote after this comment reads: “Principia, Lib. iii.” (i.e., *Principia,* Bk. iii). De Pierris invokes this passage in de Pierris (2006: 306–308) and also in de Pierris (2002: 521–522, esp. n. 38). The trouble with this argument is that Hume does not *himself* tell us that “Newton’s chief rule of philosophizing,” which he has applied in the case at hand, is Newton’s Rule III. And, in point of fact, Rule III does not have anything to do with the case Hume is talking about: the quality that Hume is writing about is “public interest and utility,” which is neither a quality “that cannot be intended and remitted” nor one that “belong[s] to all bodies on which experiments can be made.” Because Newton’s Rule III is about qualities “that cannot be intended and remitted in all bodies on which experiments can be made,” it is clear that Hume could not have been applying Newton’s Rule III in this case. What, then, is Hume talking about when he says that he has applied “Newton’s chief rule of philosophizing” to the case of “public interest and utility”? He is referring to Newton’s Rule II, which says that *“causes assigned to natural effects of the same kind must be, so far as possible, the same”* (Newton, 1687: 795). Unlike Rule III, Newton’s Rule II is directly applicable to the case Hume is describing in the passage in question in the *Enquiry*, Section 3: that is, it licenses the move from one natural effect (moral approbation in the case of justice) to another “of the same kind” (moral approbation in the case of benevolence) and assigns the cause of the one (public interest and utility) to the other. And unlike Rule III, Newton’s Rule II, *is* included in Hume’s own rules of reasoning—a version of it appears in Hume’s Rule IV (and in its close relation, Rule V) (T 1.3.15.6–7/173–4).

This suggests that it is Newton’s Rule II that Hume considers to be “Newton’s chief rule of philosophizing”—an interpretation that fits well with what Hume writes about method in both the *Treatise* and in his later writings. It also reinforces the view that Hume rejects Rule III as being that part of Newton’s philosophy that is worthy of being adopted and immitated. Indeed, Hume’s point is precisely that it is Rule II, *chiefly,* that we should be interested in. Rule III, with its extravagant claims concerning the presence of supposedly essential qualities in every body in the universe far from common life is one we can afford to set aside.

(69.) A number of scholars have suggested that Hume’s aim in *Treatise* Book 1 is something akin to a critique of the powers of the mind—by which is meant an inquiry

whose purpose is to establish the limits of what may be known by means of the respective sciences. This has been emphasized in different ways in Laird (1932/1967: 22), Capaldi (1967: 69–70, 81) Garrett (1997: 10), Mounce (1999: 15–21), and Waxman (2008: 172–174).

(70.) Newton concludes the Scholium to his definitions, six out of the eight of which are concerned with defining what is meant by "force," with the statement that "in what follows, a fuller explanation will be given of how to determine true motions from their causes, effects, and apparent differences, and, conversely, of how to determine from motions, whether true or apparent, their causes and effects. For this was the purpose for which I composed the following treatise" (1687/1999: 413–414).

(71.) That this is a discussion of Newtonian forces has often escaped the attention of readers for a number of reasons, not least of which is the fact that in *Treatise* Book 1, Hume uses the word *force* almost exclusively to refer to mental forces such as the "force and vivacity" of ideas. The only section of Book 1 in which the term force is consistently used in something resembling its physical sense is Part 3, Section 14—and, in particular, T 1.3.14.4–29 /157–69.

(72.) His use of the term force as inseparable from necessity or causes leads to frequent Humean usages such as "the secret force and energy of causes" (T 1.3.14.7/158), which means that it isn't really possible to come up with a neat picture of the way Hume uses the word force even in T 1.3.14.

(73.) The conjunction of Hume's fourth and seventh rules produces a new rule: "An effect always holds proportion with its cause" ("Of Interest," ESY 297). We can call this "Hume's ninth rule;" Hume uses it to rule out alternative causal hypotheses in his criticism of mercantalism, as well as in the use of analogy in the Newtonian "argument from design" (see EU 11 and D 5–7).

(74.) For Newton's use of the term *effects* in this way, see Proposition 66 of *Principia*, Book I: "[T] hese forces … will always act in the same way and in the same proportion; thus it will necessarily be the case that all the effects will be similar and proportional and that the times for these effects will be proportional as well." (1687: 580); and Proposition 52 of Book II: "[S]ince the proportion of the causes remains the same, the proportion of the effects—that is, the proportion of the motions and the periodic times—will remain the same" (1687: 783).

(75.) Two such instances appear in the next two passages we have quoted from Hume: the one beginning "Tho' the several resembling instances;" and the one beginning "[W] e are led astray by a false philosophy." We have added emphasis to highlight this point.

(76.) Or, as Hume puts it: “[M] atter is confess’d by philosophers to operate by an unknown force” (T 1.3.14.12/App. 633).

(77.) This way of phrasing the example is taken from Smeenk and Schliesser (2013). For recent treatment of the moon test, see Harper (2011).

(78.) “To every operation there is a power proportioned; and this power must be plac’d on the body, that operates” (T 1.3.14.26/167–8).

(79.) “As to what may be said, that the operations of nature are independent of our thought and reasoning, I allow it… . But if we go any farther, and ascribe a power or necessary connexion to these objects; this is what we can never observe in them, but must draw the idea of it from what we feel internally in contemplating them” (T 1.3.14.28/168).

(80.) For other attempts, see Sturm (2014).

(81.) See Russell (2008).

(82.) See Norton (2010).

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