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Newton and Hume

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1. Related Topics

Newton, Newtonianism, Hume, Experimentalism, Induction, The Metaphysics of Forces, Causation, Space and Time, Cartesianism

2. Introduction

We may distinguish two interpretations of the relation between Newton's natural philosophy and Hume's science of human nature. The first interpretation can be called 'traditional,' the second 'critical.'

The traditional interpretation (Capaldi 1975; Force 1987; Buckle 2004; De Pierris 2006; Millican 2007; Slavov 2013; Brown and Morris 2014) suggests that in laying the foundations for his science of humanity, Hume imitated Newton's natural philosophy. He incorporated Newtonian methodology and reasoning in his overall philosophical project. The central tenet in the traditional outlook is Hume's adoption of Newton's anti-hypothetical experimentalism. Perhaps the clearest example of a reading like this is provided by Brown and Morris (2014, 19, 23). In their view,

> "Hume, like Newton, is opposed to philosophers and scientists advancing speculative hypotheses and imposing their conjectures and fancies on us […] Newton's scientific method provides Hume with a template for introducing the experimental method into the study of human nature, as the subtitle of the *Treatise* telegraphs."

The critical interpretation (Laudan 1981; Jones 1984; Barfoot 1990; Schliesser 2009; Ducheyne 2009; Boehm 2013, 2016; Hazony 2014) challenges this. According to Miren Boehm (2016, 1-2),

> "interpreters have actually underestimated how misleading the traditional picture actually is. For there is an absolutely crucial and fascinating fact about Hume's philosophical intentions that, in a sense, reverses the traditional understanding of the Hume-Newton relationship. Hume conceives of his own science of man neither as subordinate nor even as standing alongside Newton's natural philosophy. In fact, Hume envisions his science of man as occupying a *foundational* role with respect to all sciences, *including* Newton's (T Intro 8). Hume understands the natural philosophy of Newton to be *dependent* on his science of man (T Intro 4-5)."

In the Introduction to his *Treatise*, Hume writes that Newtonian sciences like "*Mathematics, Natural Philosophy, and Natural Religion*, are in some measure dependent on the science of Man; since they lie under the cognizance of men, and are judged of by their powers and faculties" (T Intro 4; Schliesser 2008, Section 1). The critical interpretation emphasizes Hume's ambition to establish the science of humanity as "the only solid foundation for the other sciences" (T Intro 7). All disciplines are to a considerable degree dependent on Hume's foundational project. According to this view, Hume epistemically privileges his humanistic science over any type of natural philosophy, including Newton's dynamics or optics.

The rest of this article will not side either with the traditional or the critical interpretations of Hume's Newtonianism (or with some middle positions, like Schliesser 2008 or Slavov 2016). Instead, essential points of confluence and divergence will be discussed.

3. Experimentalism and Criticism of Hypotheses

In Rule 3 of his "Rules for the Study of Natural Philosophy" of the *Principia*, Newton argues that we can know about the qualities of bodies through experiments and by induction (see entry "Newton's Rules of Reasoning," Miller 2009, and Biener 2018). Here 'experiment' means something like 'experience.' For example, we know the hardness of bodies by experience. In the past, we have touched a number of bodies and hence we predicate hardness of bodies universally. Likewise, we do not need to test, for example, gravitational acceleration in all places in the universe to establish that such acceleration is universal. Newton articulates what we today would call Humean induction: factual knowledge concerning the qualities of bodies is founded on an extrapolation from the observed to the unobserved.

In the Introduction to his *Treatise*, Hume argues that our knowledge about bodies (or minds) comes from "careful and exact experiments." He sets limits to the acquisition of knowledge: we can never "go beyond experience; and any hypothesis, that pretends to discover the ultimate original qualities of human nature, ought at first to be rejected as presumptuous and chimerical" (T Intro 8; SBN 8). Like Newton, Hume denies that we could predicate any quality of a body based on our reason alone. In his first *Enquiry*, he provides several examples to support the thesis that we can predicate properties or predict effects only by experience. One cannot know, prior to and independent of any experience, that flame causes heat, that gunpowder explodes after ignition, or that lodestone attracts metal.

Although Newton's articulation of Rule 3 and Hume's experimentalist starting point are analogous, usually the two do not use the term 'experiment' in the same way. For Newton, experiment also denotes a highly idealized system (where it does not for Hume). This system includes salient variables that can be manipulated. For example, in Proposition 6 of the third Book of the *Principia*, Newton reports a pendulum experiment with nine different materials in a wooden box. The invariant periods of oscillations with the materials in the experiment confirms (within a minuscule margin of error) that the gravitational acceleration is independent of the mass of the falling object near the surface of the Earth. By 'experience' Hume means observations and memory of constant conjunctions of species of objects or events in the past (T 1.3.6.2). Hume thinks we identify causal relations and laws of nature with experience. He does not pay attention to the fact that experiments include error estimates. Rather, he treats them as if they yielded exact conclusions. Also, experiments in Hume's own science of human nature differ from those of natural philosophy as the former do not make predictions (Demeter 2012, 582).

4. Force and Causation

In Newton's dynamics, force is a key concept. Without forces, there would be no change of motion. Newton believes that forces are real, not mere calculating devises for making predictions. In the General Scholium at the very end of the *Principia*, he concludes that "it is enough that gravity really exists and acts according to the laws that we have set forth and is sufficient to explain all the motions of the heavenly bodies and of our sea." The force of gravity brings about a range of changes of motion: free fall, trajectories, the tides, planetary, satellite and cometary orbits.

Hume's position on the ontology of forces is controversial. The traditional take on his position is that he rejects the existence of, or is agnostic about, causal powers. Hume does not have any specific definition of the concept of force. Rather, he uses it synonymously with necessary connection, energy, and power (EHU 7.3). He argues that we experience constant conjunctions of objects or events, but we do not perceive a connection among them (EHU 7.21). Moreover, Hume's copy principle states that simple ideas are caused by simple impressions, and that the former replicate the intrinsic features of the latter. Compare this to Newtonian forces, which are unobservable causes; we do not see, for example, gravity pulling the Moon toward the Earth. Given the copy principle, how could Hume assimilate any unobservable causes to his ontology? What is the ontological status of forces?

Here we may consider two alternative responses to the question. The so-called Old Hume interpretation maintains that we have an impression of reflection of causal power or necessity. The notion of a causal power is nothing drawn from the causal relations themselves. After witnessing repeated constant conjunctions, we feel that there is necessity in the world, a causal power that brings about their effects. But it turns out that the notion of necessity is, as Peter Millican (2009, 648) puts it, "a reflexive awareness, of making customary inferences in response to observed constant conjunctions." Necessity is in the head. This view is consistent with an instrumentalist philosophy of science: the concept of force is an instrument that enables scientists or engineers to predict various motions but remain neutral about the existence of forces. The magnitudes of causes and effects can be expressed in precise mathematical terms (for this point, see Demeter 2014, 175). By such instrumentalism, Hume remains agnostic on whether there are mind-independent powers or forces that necessitate and ground laws of nature. In contrast to the Old Humean interpretation, the New Hume interpretation argues that there are hidden powers that are productive of manifest phenomena. This reading takes Hume to hold that although we cannot have any definite description of the unknown something that causes the perceivable effects, we nevertheless know that it exists, and we can refer to it. Galen Strawson (1989) argues that the underlying, unobservable reality is what ultimately explains the observable, inductively established regularities.

Newton would agree with the New Hume. Newton is clear that forces are causally efficacious, although he does not develop an elaborate philosophy of causation. In his explanation of the first law in the Axioms of the *Principia*, he does mention something like a counterfactual condition for causation: bodies remain in their inertial state of motion unless there is an external force applied to the bodies (see entry "Law of Inertia, the"). For example, when I throw a rock, it should, according to the first law, move rectilinearly to infinity. But instead of a straight line, the rock's motion is parabolic, and it will eventually stop because of air resistance and friction. The counterfactual point is that if there were no external forces (like gravity, drag, and friction), the motion of the rock would be rectilinear.

In his "Rules by which to judge causes and effects" of the first book of the *Treatise*, Hume argues that contiguity and succession are relevant conditions for causal relations. This means, roughly and broadly, that Newton's laws of motion and the law of universal gravitation are inconsistent with Hume's rules for causation. Newton's laws countenance instant distant action, thus violating both succession and contiguity. Hume's concept of causation seems to be, perhaps surprisingly, closer to Cartesian mechanistic natural philosophy than Newton's dynamics. Cartesian science takes its model from the collisions of bodies and the workings of machines (see entry "Descartes' Mechanical Philosophy"), whereas Newtonian science models nature in terms of interacting forces between masses. Hence there is a clear tension between Newton's causal laws and Hume's concept of causality.

5. Space and Time

Because Newton (1999, 412) thinks that forces are real and causally efficacious, there must be a difference between accelerative and inertial motion: "The causes which distinguish true motions from relative motions are the forces impressed upon bodies to generate motion." If something really, not just relatively, moves, there must be an absolute benchmark to which the motion can be compared. In the Scholium to Definitions in *Principia*'s first Book, Newton argues for absolute and universal structures of space and time.

Absolute space exists by itself, independently of anything material (see entry "Absolute Space"). It is three dimensional, entirely homogenous, and extends to infinity. This space makes the notion of absolute velocity meaningful: there is an objective, observer-independent difference between rest, motion with constant velocity, and acceleration. Bodies move definite distances within absolute space. As bodies move definite distances, they do it in definite times. A body not influenced by a force moves equal distances in absolutely equal intervals of time. To the contrary, a body subjected to a constant net force moves unequal distances in absolutely even temporal intervals (DiSalle 2016, 41). The argument for these absolute and universal structures indicate that Newton's laws of motion are objective descriptions of material reality, and that these laws apply universally. Whether a body is subjected to Newton's laws is independent of setting up an inertial frame of reference; the absolute Euclidean space itself already makes up the frame of nature itself.

Hume's position on space and time stands in a stark contrast to Newton's. Before Newton (1999, 408) establishes absolute space and time in his *Principia*, he notes that we should eliminate a typical preconception, according to which space and time are "conceived solely with reference to the objects of sense perception." He points out that abstraction from the senses is required. When

Hume presents his views on space and time, we can see that his approach is entirely different from Newton's:

> "As long as we confine our speculations to the appearances of objects to our senses, without entering into disquisitions concerning their real nature and operations, we are safe from all difficulties, and can never be embarrass'd by any question [...] If we carry our enquiry beyond the appearances of objects to the senses, I am afraid, that most of our conclusions will be full of scepticism and uncertainty" (T 1.2.5.26; SBN 64, fn. 12).

In Hume's theory, as he presents it in the first Book of the *Treatise*, we acquire the idea of space from visual and tactile impressions. We get the idea of an extended object from a collection of impressions of colored and solid finite corpuscles. Here Hume is closer to Descartes than Newton: bodies constitute space, they are not in space. For the abstract idea of time, we need to perceive a succession of indivisible impressions. We could not abstract or conceive time without changeable objects (Coventry 2010, 82-83).

Related to the ontology of space, Newton and Hume also disagree on the existence of a vacuum. Propositions concerning Newton's laws depict highly idealized cases. Newton finds inductive support for his laws from Boyle's air pump experiment. His own words in the General Scholium capture the quintessential role that the vacuum plays in his science:

> "The only resistance which projectiles encounter in our air is from the air. With the air removed, as it is in Boyle's vacuum, resistance ceases, since a tenuous feather and solid gold fall with equal velocity in such a vacuum. And the case is the same for the celestial spaces, which are above the atmosphere of the earth. All bodies must move very freely in these spaces, and therefore planets and comets must revolve continually in orbits given in kind and in position, according to the laws set forth above. They will indeed persevere in their orbits by the laws of gravity…"

For his part, Hume denies that we have an idea of a vacuum. According to him,

> "*the idea of space or extension is nothing but the idea of visible or tangible points distributed in a certain order*; it follows, that we can form no idea of a vacuum, or space, where there is nothing visible or tangible" (T 1.2.5.1; SBN 53).

Hume's doubts about the existence of a vacuum establish his kinship to Cartesian, as opposed to Newtonian, natural philosophy (see entry "Descartes' Mechanical Philosophy"). In his *Principles of Philosophy* (2.11), Descartes argues for the similarity of extension and space: "If we concentrate on the idea which we have of some body […] we shall easily understand that the same extension which constitutes the nature of body also constitutes the nature of space." Consequently, a vacuum, that is, a putative space devoid of all matter, cannot exists. Descartes plenist conclusion in his natural philosophy is based on his substance metaphysics: bodies are substances, and their primary attribute is extension; and bodies are the subject matter of physics. This is very different from Hume's starting point, the copy principle. Still, the comparison to Descartes shows how different Hume's account is from Newton's.

6. Cross-References

Absolute Space

Descartes' Mechanical Philosophy

Law of Inertia, the

Newton's Rules of Reasoning

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