RADICAL CHANGES IN THE DISPOSITIONS OF MATTER IN BOYLE, NEWTON, AND HUME

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In his *Origin of Forms and Qualities* (1666), Boyle proposed a now classic dispositional explanation of how a body's sensible qualities such as color come to be manifested when that body interacts with another body which happens to be a man or other sensitive animal. Using the metaphor of the relationship between a lock and its key, he described the quality of color, for example, as the disposition of one body to manifest a color whenever another body (the human observer) serves as the key that unlocks the relevant color disposition in the first body. But his dispositional explanation of sensible qualities did not fully distinguish between two sorts of questions: (1) How do atoms and their combined texture constitute the dispositions of whole, middle-sized bodies? That is, how does the causal interaction of one body's atoms with those of another operate *to make manifest the respective dispositions* of the two bodies? (2) In cases where one of the bodies is a human perceiver, how does the causal interaction between the observed body's atoms and the human body's atoms produce the human's *idea, or mental representation*, of a sensible quality belonging to the other body? These questions had arisen because of Boyle's denial that certain sensible qualities like color are essential, or categorical, properties of bodies. To explain the quality of color, for instance, he had stipulated that color has a merely dispositional existence that is somehow grounded in the absolute, or categorical, existence of the size, shape, and motion of the colored body's atoms and their combined texture.

Newton's radically different approach to defining the dispositions of matter turned Boyle's theory of dispositions on its head by showing that Newtonian mass could be conceived as an exclusively dispositional property of bodies without requiring that mass be causally grounded in the categorical properties of Boyle's matter. On Newton's view, a body's disposition of mass, when conceived as a natural force, constitutes an existence more fundamental than that of Boyle's matter. He thus questioned whether the categorical properties of matter, which Boyle had treated as the causal basis of scientific explanations, should not themselves become the explananda to be explained by the dispositional property of mass. Newton's willingness to investigate the categorical properties of Boyle's matter as themselves *phenomena*, whose fundamental nature required further dispositional explanation, radically transformed the *very idea of a disposition of matter*.

Two features of Newton's dispositional account of mass should be underscored at the outset. In his *Philosophiae naturalis principia mathematica* (1687), mass was described both in dispositional terms and in terms of mathematical relations among several kinds of measurable phenomena. However, in *De gravitatione et aequipondio fluidorum* (c. 1664-85), Newton also affirmed the possibility that the disposition of a body to manifest the property of impenetrability depends on the disposition of God to perceive and to will that certain parts of space exhibit relations between the measurable phenomena of motion. If this possibility were realized, the property of impenetrability would depend on a divine phenomenalism in which God, who necessarily exists, renders the property of impenetrability real by means of his perceiving and willing the relevant phenomena of motion. Therefore the reality of impenetrable matter would be

a dependent reality because the relations of the phenomena of motion perceived and willed by a divine observer would, on this view, ground the reality of impenetrable matter.

What is distinctive about Newton's divine phenomenalism in *De Gravitatione* is its genuinely realist purpose, its attempt to ground the dispositional existence of matter's properties. However, this grounding depends on *something mental* which defines what it means to be impenetrable and moveable. For, without that *something mental*, namely, God's thinking the mathematical principles of natural philosophy, matter's dispositional properties would be unintelligible. Hence it is not surprising that, on Newton's account in the *Principia*, human beings have sufficient warrant to believe that a body's disposition to react to an impressed force is *the same as* its disposition to be perceived by a human observer as changing its motion. The human observer is here warranted by an analogy of reason to think, just as Newton's God does, about the body's mass as a single disposition that necessarily links both the body's changing motion and *its appearance to an observer* of changing motion.

Indeed Newton's God is indispensable to his physics because to separate his theology from his physics is to challenge not only the credibility of his dispositional account of impenetrability in *De Gravitatione* but also his dispositional account of mass in the *Principia*. Suppose, however, that you are a religious skeptic and yours is an empiricism that, while it continues to accept his physics, nonetheless rejects his analogy of reason between human and divine observers. How would your acceptance of his physics, if it were divorced from its divine phenomenalism, shape your beliefs about matter and your beliefs about yourself as an observer of phenomena?

Newton's most important legacy to Hume was his account of mass as a dispositional property of matter because that account showed how even a property like mass can be treated in terms of phenomena whose fundamental nature is open to empirical investigation. But Hume never accepted divine phenomenalism, and, as a result, the Newtonian elements of his own work subverted certain claims of the very science that inspired it. Nowhere is this more evident than in Hume's reinterpretation of Newton's dispositional account of mass as instead a relational account of the perceptual states of an observer of the phenomena of motion.

Hume, in implementing it, was able to drive a wedge between his own relational interpretation of the laws of motion and Newton's dispositional interpretation of those laws. He thus formulated the view that our beliefs about scientific laws of nature can be interpreted as and warranted by relations between the perceived phenomena without reference to the dispositions of material objects and the forces they exert. Unlike Newton, therefore, Hume did not rehabilitate Boyle's lock-and-key concept of a disposition for the purpose of causally relating the phenomena of motion to the forces that cause them. Rather he chose to translate previous empiricists' talk of the dispositions of matter into talk of Humean beliefs about the law-like regularities of distinct existences.