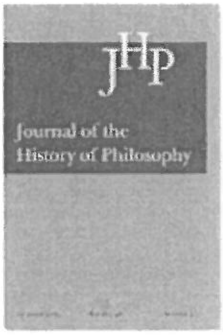
Infinitesimal Differences: Controversies between Leibniz and his Contemporaries

Françoise Monnoyeur-Broitman



Journal of the History of Philosophy, Volume 48, Number 4, October 2010, pp. 527-528 (Review)

Published by The Johns Hopkins University Press

must come from internal resources of the mind," and "brain patterns are taken as signs of their causes *because* of ideas already provided by the mind" (177).

But in an interpretation De Rosa does not examine, I have shown how resemblance works for Descartes' sensible ideas in his description of sense perception, from touch, light waves and sound waves, and particles in the nose and on the tongue. From all of these sense-organ encounters with the material world, distinctive isomorphically-keyed material motions are transferred through the nerves to the pineal gland, where brain patterns that are similar to and derived from the shapes and patterns of the material things that caused them are exhibited. This is the ancestor of the system neurophysiologists today propose to differentiate synopses reactions in the brain caused by stimuli on the sense organs. So the resemblance relation holds for sensible perception of the external world both for Descartes and contemporary brain scientists. This explains how sensory ideas give us knowledge of material bodies other than simply by saying God makes it so (see *Representational Ideas from Plato to Patricia Churchland* [Dordrecht: Kluwer, 1995], 19–48).

But never mind this quibble. De Rosa's examination of sensory representation in Descartes is both an intensive study and a masterful polemic on a subject of major concern to all Descartes scholars. It is an excellent contribution to a recent renaissance of erudite and deep studies of Descartes' epistemology.

RICHARD A. WATSON

Washington University in St. Louis

Ursula Goldenbaum and Douglas Jesseph, editors. *Infinitesimal Differences: Controversies between Leibniz and his Contemporaries*. Berlin-New York: Walter de Gruyter, 2008. Pp. vi + 327. Cloth, $109.00.

Leibniz is well known for his formulation of the infinitesimal calculus. Nevertheless, the nature and logic of his discovery are seldom questioned: does it belong more to mathematics or metaphysics, and how is it connected to his physics? This book, composed of fourteen essays, investigates the nature and foundation of the calculus, its relationship to the physics of force and principle of continuity, and its overall method and metaphysics. The Leibnizian calculus is presented in its origin and context together with its main contributors: Archimedes, Cavalieri, Wallis, Hobbes, Pascal, Huygens, Bernoulli, and Nieuwentijt.

Many of us know and probably have used the Leibnizian formula: $\int_a^b f(x)dx$ to calculate the area under a curve; this book considers the origin, nature, method, and metaphysics of this formula. The most fascinating question discussed in it is the fiction introduced to define the infinitesimal calculation: in his mature period, Leibniz himself referred to his calculus as "a well-founded fiction." We learn that he gradually gave up the idea of an *actual infinite* in favor of describing *infinitely small quantities*. As a result, the quantities became fictive and finite or indefinite instead of real and infinite, and the process of calculation shifted towards mathematics rather than metaphysics.

In the first essay, Richard Arthur compares the calculus of Leibniz and Newton and demonstrates how it was based for both on the development of continuously varying quantity. He also shows how the understanding of this quantity derived from the Archimedean axiom that excludes the existence of actual infinite quantity. Ursula Goldenbaum next demonstrates how Hobbes, with his conatus considered as point and instant, had a direct impact on the Leibnizian conception of continuity; to confirm her interpretation, she includes at the end of her article the "Marginalia or Leibniz comments" on Hobbes. Samuel Levey establishes a connection between the notion of the infinitesimal as a "well-founded fiction" and the law of continuity, arguing that the law of continuity, understood as an extension of Archimedes' principle, gives a finite foundation to the infinitesimal calculation. O. Bradley Bassler discusses the idea of the differential in terms of infinitely small quantities and the use of proportions between infinitely small and finite quantities in order to measure the infinitely small; here, differentials are also presented as fictions. Fritz Nagel discusses the methodological sophistication of the calculus and its opponents. His main questions concern the different grades of infinity, quantities regarded as zero, and the infinitesimal as a fiction that can be calculated. Douglas Jesseph considers the reality of the infinitesimal and the "well-founded fiction," showing how Leibniz methodically constructs infinitesimal quantities without reality by returning to Hobbes' notion of conatus. Hobbes is, for Jesseph, the initiator of these infinitely small quantities without existence.

A second group of essays examines the connection between algebra and geometry in the calculus. Philip Beeley demonstrates how John Wallis, on the path of Cavalieri's method of the indivisibles, found a way to transform geometric problems into sums of arithmetic sequences. Siegmund Probst expresses the different phases in the discovery of the Leibnizian method. He mentions that Leibniz coined the term 'infinitesimal' in 1673, and points out that he did not need the method of indivisibles to find a curve from its given arc, but only a series expansion using differences of higher order. Emily Grosholz looks at how, thanks to his algebraic and geometrical notations of curves, Leibniz could formulate the equation of his infinitesimal calculus. According to Grosholz, Leibniz exploits the ambiguity of notations in order to express the geometrical and dynamical aspect of the calculus. Herbert Breger underlines the novelty and abstract nature of Leibniz's new method of calculation, showing how the theory of infinitesimals became an algebraic calculus independent of geometry.

A final group of articles studies the relationship between the calculus and Leibniz's physics. François Duchesneau shows how the differential and integral calculus provided a model for the integrative laws of Leibniz's dynamics and the laws of nature in general. Donald Rutherford connects the physics of forces with the calculus, emphasizing the paradox in the nature of force, which is real and produces continuous change in time but is shaped by a fictive calculus. From there, he concludes that the continuum is a metaphysical ideal and belongs to the dynamics of the soul. Daniel Garber focuses on the role of dead force in Leibniz's physics and its connection to infinitesimal magnitude. He notices that for Leibniz, in contrast to Descartes, the mathematical entities used to model physical nature are unreal, opening the way to a new understanding of mathematical physics.

This volume is an impressive exploration of the infinitesimal calculus of Leibniz and his contemporaries, revealing unknown aspects of the history of mathematics of the seventeenth and eighteenth centuries. Surprisingly, none of these articles mentions the Newton-Leibniz controversy related to calculus. It was Newton who, prior to Leibniz's publications, created an infinitesimal calculation method based on the physics of momentum, and then later accused Leibniz of having stolen his invention. How did Newton's work figure in the development of infinitesimal calculus, and what were the effects of the controversy? It would have been interesting to explore these questions as well.

FRANÇOISE MONNOYEUR-BROITMAN

Duquesne University

Todd Ryan. *Pierre Bayle's Cartesian Metaphysics: Rediscovering Early Modern Philosophy.* New York-London: Routledge, 2009. Pp. xiv + 223. Cloth, $128.00.

Given the difficulties of Pierre Bayle's writing—its occasional nature, its digressive and wandering style, and its sheer size—it is no small task to present him as an author of a coherent metaphysical doctrine. But Todd Ryan does just that in this cogently-argued analysis of Bayle's encounters with, among others, Descartes, Malebranche, Locke, Leibniz, and Spinoza. We are thus invited, as the subtitle indicates, to "rediscover early modern philosophy" by way of Bayle's philosophical engagements.

The main fault line in Bayle scholarship concerns the sincerity of the philosopher's religious and philosophical commitments, and scholars have had recourse to biographical