Logic in Revolution

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The first revolution in logic. In 1637, Descartes published his *Geometry* inaugurating thereby the radically new mathematical practice of analytic geometry that over the course of the next two centuries would utterly transform the face of mathematics. With the introduction of Descartes' *Geometry*. ancient Euclidean diagrammatic reasoning, for over two millennia the paradigm of mathematical practice, was almost completely supplanted by the practice of constructive algebraic problem solving. Fifty years after the appearance of Descartes' *Geometry*, in 1687, Newton's *Principia* appeared, and it too proved transformative, this time of the practice of physics. Physics was henceforth to be quantitative rather than qualitative, and essentially mechanistic rather than teleological. It was also to be constitutively theoretical and postulational rather than merely observational. Exactly one hundred years after Newton's *Principia*, in 1787, the second edition of Kant's *Critique of Pure Reason* made its appearance. And as surely as Descartes and Newton had done for mathematics and physics, respectively, so Kant inaugurated a radically new form of philosophical practice. Tiles [2] argues that a central element of this transformed practice concerns the discipline of logic. If Tiles is right, Kant made a significant, and largely unrecognized, advance in logic. This advance was, I will suggest, the first real advance in logic since Aristotle founded the discipline in the fourth century BC.

The second revolution in logic. In the nineteenth century, with the work of Riemann, Dedekind, and others, mathematical practice underwent a second revolution to become, as it remains today, a practice of deductive reasoning directly from concepts. The practice of physics followed suit in the twentieth century with Einstein's special and general relativity and the emergence of quantum mechanics. Have philosophy, *and logic in particular*, enjoyed a second revolutionary transformation in the centuries since Kant? The answer, of course, is: yes. As anyone will tell you, the beginning of modern logic lies in Frege's "great works" (as Wittgenstein [3] described them) beginning with Frege's little *Begriffsschrift* of 1879 [1]. We have, then, a three-stage account of the history of (classical) logic: from the ancient Greeks, through early modern developments due to Kant, and culminating in Frege's work. It is this history that is my focus here, and I have two principal questions. First, is this historical account true? And, second, if it is true, what can it teach us about logic?

Understanding the history of logic in revolution. My focus is what, if anything, is really new with Kant, and then, what, if anything, is really new with Frege. Of course the logic that we now have, that is, the full polyadic predicate calculus, is much stronger than ancient logic, much stronger even than anything Kant envisaged. But are these logics essentially different? And if so, how? Reflecting on the larger context, the other revolutions, in particular, those in mathematics that profoundly shaped the intellectual culture that provided the context, first, for Kant's works and then for Frege's, will help us to discern significant similarities and differences that matter to our understanding of the history of logic in revolution. As we will see, there is much to be learned about Kant's contributions to logic by reflecting on Descartes' contributions to the practice of mathematics. And thinking about Frege's work in the context of nineteenth-century developments in mathematics is, we will see, similarly illuminating.

References

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3. Wittgenstein, Ludwig. *Tractatus Logico-Philosophicus*. Trans. D. F. Pears and B. F. McGuinness. London and New York: Routledge, 1961.