MZA data, Farber presents a crude analysis of blood pressure levels on 15 sets of MZA's and concludes that blood pressure is strongly influenced by heredity. At best, that conclusion merely reflects what is well established from very much larger, more representative, and more informative sets of twin, family, and adoption data. In principle, separated identical twins permit a direct estimate of heritability; in practice, MZA data are so limited that, as Farber documents, any generalization is suspect. These rare cases generate many hypotheses but rarely if ever confirm them.

Similarities in reunited MZA's have been dramatized in the popular media and in a recent account in this journal (*7*). Such drama makes good show biz but uncertain science. Resemblances of MZA's in habits, interests, and likes and dislikes are described as "provocative," "astonishing," "uncanny," and "astounding." Are they? A colleague (*8*) suggests that we cannot know without necessary control data on similarities found in pairs of age-matched strangers, and he has observed many similarities in idiosyncrasies of everyday life among paired college students brought together to discover their resemblances. Were one to capitalize on cohort effects by sampling unrelated but age-matched pairs, born, say, over a half-century period, the observed similarities in interests, habits, and attitudes might, indeed, be "astonishing."

Two analyses highlighted by Farber may represent such cohort effects. The first deals with dental similarity, the second with similarity of menstrual functioning and distress. Farber recognizes probable cohort effects in her analyses of similarity in dental history and dental structure, suggesting that MZA's are not so much similar to each other as they are similar to people of their eras. But that argument is by no means limited to dental health. Cohort effects will be operative in interests, attitudes, and education, and Farber's box-score analysis of twin pairs born from the 1890's to the 1950's may be severely confounded with cohort effects.

The analysis of IQ is the central chapter of the book. It is also the most curious. The chapter begins with arguments that lead the author to conclude that pooling of the data is not legitimate, that no analyses are, in fact, justified. Yet, the chapter continues, less cautious investigators would not hesitate to pool data with less conservative tests for bias, and besides, these are the only MZA data available. And they *are* provocative! Accordingly, the author goes ahead and performs the analysis said to be illegitimate and ill advised. What then is new about this analysis of IQ in separated twins? No change in substantive conclusions from those reached by others is obtained. It is estimated that heritability is about 0.5 and that 20 to 25 percent of the variance in tested IQ is attributable to the effects of common environments. Analyses of conventional twin data and adoption studies suggest the same conclusion. The resemblance of unrelated individuals who have been reared together provides a direct estimate of the effects of common environment, and the correlation of such individuals is on the order of .20 to .25.

Farber's detailed analyses suggest a sex by degree-of-contact interaction, but the sample sizes for these analyses are vanishingly small. The author (with Noel Dunivant, who performed the statistical analyses) concludes, "In our opinion, these results suggest a complex pattern of environmental effects on IQ which have not been detected by previous investigators." That opinion is uninformed. Modification of the expression of a genotype by environmental experience is well documented, and the documentation comes not from MZA data but from extended twin-family data for which innovative path analytic solutions have been formulated. Resolution of genetic and environmental sources of behavioral variation can be made from conventional data with tools and techniques now being developed. It is not necessary to rely on the MZA data, which, by all accounts including Farber's, may not warrant generalization.

Susan Farber's chronicle of separated twins will introduce to a wide audience data of great intrinsic interest and potential value. One hopes that serious scientists in that audience will read the original sources (*1–5*) listed below.

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Claims for Newton

The Newtonian Revolution. With Illustrations of the Transformation of Scientific Ideas. I. BERNARD COHEN. Cambridge University Press, New York, 1981. xvi, 404 pp. $37.50.

The publication of Isaac Newton's *Principia* in 1687 inaugurated a new scientific era. To mention only some of its most notable achievements, Newton here introduced a rigorous concept of force, formulated the laws of motion, mathematically demonstrated the properties of the motions of bodies under a wide variety of forces, deduced the existence of universal gravitational attraction, and applied these results to explain a spectacular range of celestial and terrestrial phenomena. For more than two centuries this magisterial achievement, the so-called Newtonian synthesis, was taken as the model for the development of all the sciences, and mechanics reigned supreme. To historians of science this represents the Newtonian revolution.

In his latest book I. B. Cohen does not so much reject this view as move beyond it. Starting from 18th-century assessments of the Newtonian revolution, he locates the truly revolutionary feature of the *Principia* in what he calls the "Newtonian style." By "Newtonian style" Cohen means the successive development of mathematical models which are compared with experiment and observation and continually refined until a model corresponding sufficiently accurately with nature is obtained; at this stage the model is applied to explaining natural phenomena; and only then are physical causes examined. Since this is essentially a description of the practice of much of contemporary science, Cohen is in fact making the rather strong claim that to Newton is due not only the development of classical mechanics but also the very way in which we do much of our science.

Cohen's concept of Newtonian style will undoubtedly prove to be a useful one for exploring the development of Newton's science and that of his era. It brings to the fore the essential role of mathematics in Newton's physics, and it clearly separates Newton's mathematical-physical analyses from his mainly subsequent concern for the physical origins of force, thereby redressing the undue emphasis in the recent literature on Newton's speculations on the various forces of nature. The concept also makes it clear that it was the *Principia*'s style and not just its content that served as a model for 18th-century science. However, since Cohen leaves the history of that style largely unexamined, it is not clear precisely how much its development and adoption ought to be attributed to Newton. Cohen grants that that style was to some extent used by Archimedes, Ptolemy, Kepler, Galileo, and Huygens, among others, but he argues that Newton "transformed" it into his own style, which more completely represented reality and treated causes. Yet taking Newton's physics more into account might reveal his greater success with this style as being due primarily to his greater success with the physics itself, allowing him to apply it more deeply to more phenomena. Huygens, for example, whose *Traité de la lumière* was composed just a few years before the *Principia*, appears to me as adept at the Newtonian style as Newton. If he was unable to proceed further with optics, it was because of the limits of his physical conceptions and the relatively undeveloped state of optical science, and not because of his style.

Newton's own work in optics presents similar difficulties for Cohen's account. It appears to me that much of the Newtonian style is already evident in the *Optical Lectures*, Newton's first physical treatise, composed between 1670 and 1672. One reason this may not have been evident to Cohen is that he draws a more rigid distinction between Newton's mathematical and experimental sciences than Newton himself did. In addition, Cohen's concept of Newtonian style is too closely associated with Newton's later and more successful mechanics, whereas Newton's announced goal in his *Optical Lectures* was to present a mathematical science of color and not physical optics or mechanical models of light. Newton was only partly successful in fulfilling his goal, but, as with Huygens's optics, I would not attribute his failure to the lack of the style he supposedly developed only a decade later.

In the second part of his book Cohen presents his concept of the "transformation" of scientific ideas. By invoking a series of transformations he attempts to establish a relatively continuous account of scientific change in contrast to Thomas Kuhn's depiction of discontinuous scientific revolutions. However, I found Cohen's concept of transformations, like Kuhn's of paradigms, too broad and vague, encompassing "a fact of experiment or observation, a method, a theory, or a concept," and I do not think that this otherwise useful concept can alone bear the burden of accounting for scientific change. Cohen promises a separate book on scientific transformations, and a more detailed presentation may well resolve these problems.

Cohen artfully interweaves the two parts of his book by illustrating his concept of transformations with examples drawn from Newton's physics. His treatments of Newton's concepts of inertia and force and his third law of motion are particularly perceptive and enlightening. Although his concepts of style and transformation may require further elaboration and precision, Cohen presents them in a lucid, stimulating manner.

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Nuclear Physics

Exotic Atoms '79. Fundamental Interactions and Structure of Matter. Proceedings of a course, Erice, Sicily, Mar. 1979. KENNETH CROWE, JEAN DUCLOS, GIOVANNI FIORENTINI, and GABRIELE TORELLI, Eds. Plenum, New York, 1980. x, 404 pp., illus. $45. Ettore Majorana International Science Series, vol. 4.

Exotic atoms are atoms in which an exotic particle is bound to other, nonexotic constituents like electrons, protons, and nuclei through electromagnetic interaction. Which of these charged particles should be called exotic has not been unambiguously defined. However, if one adopts the view that the word "exotic" stands for rare, short-lived, and artificially created, then the class of exotic atoms may range from positronium to baryonium, the bound states of e^+e^- and $p\bar{p}$ respectively.

Light exotic atoms have played an important role in the development and tests of the concept of quantum electrodynamics. This is particularly evident for the positively charged leptons positron and muon, e^+ and μ^+. Compared with hydrogen, they offer the advantage of the absence of any strong interaction effects. More and more refined measurements, particularly in muonium, have stimulated a step-by-step improvement of quantum electrodynamic theory. As V. W. Hughes points out in the first two papers of the book reviewed here, even the tiny contribution of the weak interaction predicted by unified gauge theories may eventually be isolated in such experiments.

Exotic atoms are well suited for the study of fundamental interactions. Replacing an electron or a proton by a muon, pion, kaon, or antiproton results in drastic changes of atomic parameters like mass and radius, and as a consequence the higher orders of the basic interaction between the particles involved become more pronounced. Also, in exotic atoms the contributions of other fundamental interactions may be enhanced enough to be measurable. Several papers in the first section of the book deal with issues of this kind. Muon capture in hydrogen by weak interaction is sensitive to the pseudo-scalar coupling strength. Recent experiments are discussed by J. Duclos. Anomalous muon capture by processes in which the common laws of lepton number conservation are violated is treated by B. Hahn and T. Marti, with new upper bounds for such processes. P. G. H. Sandars reviews closely related experiments in nonexotic atomic physics that look for parity nonconservation in atoms and molecules. Results in this field are somewhat contradictory; improved experiments with better systems are under way. L. Grenacs, in a paper on polarization experiments in the Godfrey-cycle for the $A=12$ mass triplet, confirms that the weak magnetism found in the β^- decay of ^{12}B to ^{12}C also is found for the corresponding μ^- capture in ^{12}C. The experiments exclude the presence of second-class axial vector currents in β-decay.

The second section of the book deals with quark atoms, which are defined as heavy quark-antiquark systems like proton-antiproton ($p\bar{p}$). T. Appelquist reviews developments in theory and experiments, particularly those concerning the lifetime and decay modes of such systems, from the perspective of quantum chromodynamics. J. Rafelski and R. D. Viollier consider refined approaches to the potential of quark-antiquark pairs, and H.-M. Chan illuminates the question whether bound systems like $p\bar{p}$ should be considered as a nuclear atom consisting of two oppositely charged nucleons or as a color molecule consisting of two quark-antiquark pairs.

The remaining two sections of the book are devoted to muons in chemistry and solid-state physics. The liaison between the sections on fundamental interactions and those on applications to the structure of matter seems artificial at first; however, the particles and the accelerators, and quite often the scientists, are identical for these studies. There is also quite a large overlap in instruments and experimental know-how.

The third section contains papers devoted to questions of atomic capture and transfer processes of muons and fast muonic chemistry by M. Leon, H. Schneuwly, A. Bertini, A. Vitale, and J.