physiology. We are reminded of the debt of Barcroft and Bayliss, of Henderson and Cannon, and of Sherrington, Haldane, and Starling to the integrative concepts developed by Bernard. Marcel Florkin has a brief but thoughtful article on Bernard and the beginnings of biochemistry, and Bernardo A. Houssay discusses the idea of integration and stability of functions in the organism as understood by Bernard. Other papers by Georges Canguilhem, Pierre Vendryès, Reino Virtanen, Raoul Kourilsky, Marc Klein, Otakar Poupa, and L. N. Karlik raise questions about theory and technique of experimentation, Bernard and the scientific milieu of his day, Bernard's negative attitude toward Darwinian evolution, and his relationship to clinical medicine. The most significant contribution to this symposium is made by Mirko Drazen Grmek in his paper on the development of Bernard's concept of the *milieu intérieur*; and this is as it should be. There is little doubt that Grmek has come to know Bernard's mind and work as few other men do. Ever since the Collège de France gave Grmek the task of assembling a catalog of the substantial archival collections of Bernard material in its possession, he has immersed himself in the writings of the French physiologist and provided us with significant new insights into the modes of thought and methods of work of Bernard. The published catalog with its extensive bibliography is an indispensable resource for anyone attempting a study of Claude Bernard.

The University of Minnesota was the sponsor of another commemorative symposium, and the resultant volume, *Claude Bernard and Experimental Medicine*, has been edited by Francisco Grande and Maurice B. Visscher. The papers are again of mixed quality, several serving as little more than "celebrations" of the French physiologist, others attempting serious historical analysis. Owen Wangensteen, surgeon and historian of medicine, sets Bernard's work on digestion in the context of experimentation that preceded and followed it. A review of the roots of Bernard's work on the vasomotor system is given by Hebbel H. Hoff and Roger Guillermin; and Frederic L. Holmes provides a brief report of his significant examination of the origins of the concept of the *milieu intérieur*.

Appended to the Minnesota symposium volume is a translation of Bernard's famous *Cahier Rouge*, an unpublished notebook containing entries covering the period 1850–1860, dealing with a wide variety of experimental and philosophical problems. Although a partial text of primarily philosophical comments had been published by Léon Delhoume in 1942, the advent of the centenary of the *Introduction* encouraged Hebbel H. Hoff and Lucienne and Roger Guillermin to prepare the translation of the full notebook. Almost simultaneously M. D. Grmek undertook publication, in French, of the full notebook, *Cahier de Notes, 1850–1860: Edition Intégrale du "Cahier Rouge"* (Gallimard, Paris, 1965). It is hard to claim that we will learn much from these notes that we could not have gained from published sources. True, the historian will be aided in his efforts to place things in their proper order—publication often serves to falsify the actual sequence of ideas and procedures—but Bernard was always remarkably candid in print. For today's scientist, however, there must be a certain excitement in being able to look over the shoulder of some giant of the past and observe just what it was that filled his intimate thoughts, see his sketches, read his experimental designs, and ponder his queries. We can observe Bernard grappling with one of the pressing problems of biological explanation, physical reductionism:

> The physicochemical phenomena do not produce the physiological properties, and it can be admitted that the physiological property changes into physicochemical phenomena but not the reverse. The chemical phenomena show the results of the destruction of matter which has fulfilled its physiological phenomenon, but it is not they which produce the physiological properties [p. 79].

The final book under review, Joseph Schiller's *Claude Bernard et les Problèmes Scientifiques de Son Temps*, constructs Bernard's scientific biography within the context of the work that other scientists were doing on similar problems. The interplay of Bernard the scientist and Bernard the philosopher comes through well, and one leaves this study with renewed appreciation for a careful yet daring experimenter, ever conscious of the relationship of experiment to explanation.

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Tracing the Expression of Heredity in Behavior

Behavior-Genetic Analysis. JERRY HIRSCH, Ed. McGraw-Hill, New York, 1967. xviii + 552 pp., illus. $12.50.

Genetic Diversity and Human Behavior. J. N. SPUHLER, Ed. Aldine, Chicago, 1967. xii + 291 pp., illus. $7.50.

The effect of heredity on behavior is one of the fundamental problems of biology and psychology. In biology, behavior is directly related to the theory of evolution, since natural selection depends upon the process of adaptation, and behavioral responses are major forms of adaptation in all animals that are capable of behavior. In psychology, genetic differences are a major source of variation between individuals and must be taken into account in any effort to make human behavior predictable.

For workers in the field of behavior genetics, a major problem is that of determining the next logical step in the development of this science. The question "Does genetics affect behavior?" has by now been answered with an emphatic "yes," but there are still many important kinds of behavior that have not been explored in this fashion. The question of whether or not genetic effects are important is no longer a burning issue and needs to be raised only in certain practical situations. Nature and nurture are interdependent. Neither can exist without the other, and there is no general answer as to their relative importance. Where should behavior genetics go next? The question of *how* heredity affects behavior still remains largely unanswered, and this is the theme of much of the work that is reported in these two volumes.

To present this question of *how* in a different sort of perspective: We know that the primary action of the genes is that of catalysts or enzymes affecting ongoing chemical processes within cells. Between this intracellular activity and behavior, which involves activity of the whole body, there is usually a long chain of intervening processes, any one of which can be independently affected by hereditary factors. An extra dimension of variability is added by the fact that behavior is an adaptive process and hence variable. Hence there

is often no one-to-one relationship between genetics and behavior, particularly if one measures behavior as performance (really a measure of adaptation).

A very promising approach is to study a biochemical system closely related to behavior. Genetic effects on each biochemical process are possible. Hamburg and Lunde point out (in the Spuhler volume) that there are at least five different genetic effects on the metabolism of human thyroid function, which has long been known to be strongly related to general activity and intellectual functions. In the Hirsch volume, Hamburg similarly reviews the adrenocortical stress mechanism, Hsia describes the now well-known biochemical mechanisms of phenylketonuria, and Ginsburg shows that biochemical mechanisms affecting audiogenic seizures in mice can be localized in particular cells of the brain. Caspari reviews the evidence connecting RNA with memory, and Eugene Roberts presents a biochemical model of synaptic action.

Another approach is to study the relationship between behavior and anatomy, where clear-cut genetic effects are often obtained because the process of growth is fairly closely related to primary gene action. In the Hirsch volume, Lindzey argues for the study of the relationship between motor capacities and behavior; and in the other book Kalmus presents a similar argument concerning the effects of differences in sensory capacities. Rodgers and Thiessen christen such structure-function relationships "mechanism-specific relationships."

The appearance of two symposium volumes on the same general subject, with considerable duplication of authors (six participants appear in both volumes) brings up the question of the value and usefulness of such volumes. In the first place, this is not the easy way to write a book. The Spuhler volume is based on a conference held in 1964, and the Hirsch book arose out of a conference held in 1961. Conceivably, either editor could have devoted the same time to writing his own complete book and given it a more unified viewpoint.

The value of such collaborative efforts is that they may serve as an encyclopedia of factual material for a period of five to ten years. The value of the compendium, of course, depends upon the choice of authors, the effort they put into their chapters, and the efforts of the editor to integrate and organize their material so that it presents adequate and easily available coverage. The Hirsch book is unusually good, judged by these criteria, and shows the results of the long years of effort which have gone into its preparation.

The two books, then, can be used as an encyclopedia of behavior genetics. The Spuhler volume emphasizes human aspects and the historical approach, while Hirsch's book concentrates on basic biology and methods. Do the two volumes adequately cover the general subject of behavioral genetics? This subject can be approached through any of the conventional subdivisions of genetics: molecular, cellular (including Mendelian), physiological, organismic, social, and ecological (or population) genetics. In addition, there are two approaches which cut across all these fields—developmental genetics and evolutionary genetics. Proponents of most of these approaches are found in the two volumes, and have generally made excellent cases for them, although the treatment is much more extensive in some areas than others. Cytogenetics is omitted in spite of the known relationships between chromosome anomalies and behavior disorders such as mongolism. Social genetics is represented only by Spuhler's chapter on inbreeding and assortative mating in human populations. Ecological genetics and developmental genetics of behavior are confined to a brief though excellent chapter by King, who points out that behavior has an effect on genetics as well as vice versa. Papousek's chapter on human development is largely confined to age effects.

The Hirsch book is an excellent reference source for the techniques of quantitative genetics as applied to behavior, with chapters by R. C. Roberts, Broadhurst, Hirsch, Bruell, and DeFries on different aspects of these methods. Lovely as they are from a biometrical viewpoint, these methods give best results when applied to processes directly affected by primary gene action and yield diminishing returns when applied to behavior that is indirectly affected through networks of physiological processes and modified by adaptation. McClearn balances this material with a summary of other sorts of genetic analysis.

Both books contain chapters on the evolution of behavior. Dobzhansky contributes a sound approach to the relationship between human biological and cultural evolution. Caspari suggests that genetic variation facilitates social organization by permitting the recognition of individuals, and Washburn and Shirek briefly summarize current evidence on human ancestry.

Still another criterion for judging the excellence of an encyclopedic approach to this subject is the inclusion of genetic studies on certain kinds of behavior which have unusual theoretical or practical importance. Among these are basic behavior patterns, which are the raw material of natural selection as it applies to behavioral adaptation, and there are excellent chapters by Rothenbuhler on the genetics and general behavioral biology of honeybees and by Manning on the genetics of behavior in other insects. Work on variation in behavior patterns and social behavior of vertebrates is for the most part omitted, with the exception of Ginsburg's coverage of the genetics of agonistic behavior in house mice.

Emotional behavior, which is of great importance in human behavior in both its normal and abnormal aspects, and which is known to produce major effects upon performance and problem solving, is largely omitted except for the experiments of Broadhurst and others on the emotional defecation of rats—a phenomenon with somewhat limited intrinsic interest. On the other hand, there are excellent chapters on intelligence (now usually called cognition) by Vandenberg and by Spuhler and Lindzey, who review the same material with respect to racial differences.

These two books, together with Vandenberg's *Methods and Goals in Human Behavior Genetics* (1965) and Fuller and Thompson's earlier textbook, *Behavior Genetics* (1960), provide a valuable and adequate group of basic references. The two volumes reviewed here are not easy reading, and parts of them are highly technical. The Spuhler volume has almost no illustrations, and the Hirsch book is printed with narrow margins and in sans-serif type, which this reader, at least, finds hard to follow. These are books for professional behavior geneticists and their graduate students. They are also authentic source books for anyone wishing to track down the facts with respect to the effects of genetics on practical aspects of behavior.

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