qualities and extrinsic support received from others. She also demonstrates that the concept of relative power can be invoked to explain how rhesus macaques maintain their adult rank positions.

These contributions are important for several reasons. First, they demonstrate the utility of studying behavioral phenomena at several different levels of organization. Second, they show how emergent properties, such as relative power, may be identified. Third, they identify a set of behavioral principles that can be applied in other contexts and may apply to other species with similar forms of hierarchical organization. Finally, they demonstrate the usefulness of Hinde's inductive approach. In the absence of a cogent theory of the function and evolution of linear matrilineal dominance hierarchies, dominance interactions among macaque females might not have been studied by Datta or others before her, and our understanding of the dynamics of macaque social organization would be much less complete.

Ecological influences upon social behavior are neglected in Hinde's conceptual framework. Few of the empirical or theoretical contributions in this book assess the relationship between environmental conditions, social behavior, and social structure. Among the exceptions are several contributions that indicate that environmental conditions are related to patterns of activity, frequencies of social interactions, and characteristics of social relationships within groups (Lee); participation in intergroup encounters (Cheney); and social structure (Dunbar; Wrangham; Moss and Poole). Clearly, social behavior is influenced by environmental conditions. Perhaps in the next edition of *Primate Social Relationships* ecological factors will be more fully integrated into Hinde's conceptual framework.

This book is an important addition to the animal behavior literature. Conceptual, empirical, and theoretical issues are thoughtfully integrated, and the emphasis upon proximate, developmental, and functional approaches is carefully balanced. In addition, a number of the empirical and theoretical contributions are important independent contributions to our knowledge of primate social behavior. In short, the book will stimulate readers to think critically about the form and function of social behavior, an exercise many of us will profit from.

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Successors to Newton

Optics after Newton. Theories of Light in Britain and Ireland, 1704–1840. G. N. CANTOR. Manchester University Press, Dover, N.H., 1984. x, 257 pp., illus. $25.

In *Optics after Newton*, G. N. Cantor provides a synthesis of what obviously has been painstaking research into 18th- and early 19th-century optics as practiced in Britain and Ireland. Cantor adds new detail to previous histories of the topic, but the most important aspect of his work is not the data but his interpretation of them.

Cantor labels William Whewell's 1837 sketch of the topic (*History of the Inductive Sciences*) oversimplified and "Whiggish" and contends that Whewell's perspective has been widely and uncritically followed by historians to the present day. He analyzes several "uncritically" accepted "Whewellian" dogmas: (i) that in the 18th century "while nothing was added to our knowledge of optical laws, the chemical effects of light were studied to a considerable extent" but that since the "chemical speculations" belonged to "other subjects" optical theory remained a "blank"; (ii) that Newton's dominance sustained the corpuscular theory in the 18th century; (iii) that 18th-century optical theories can be usefully classified into two dichotomous varieties—either wave or particle; (iv) that Thomas Young is the revolutionary hero in establishing the 19th-century wave theory; and (v) that Henry Brougham's uninformed castigation of Young's work destined the latter's efforts to oblivion until rescued by Augustin Fresnel.

To the first contention Cantor allows some validity, but also argues that its acceptance has led historians to overlook important forms of activity: the transformation of "Newton's hints" into a popular pedagogical format; the extension of the projectile theory to its limits; and the connecting of optical investigation with theology and with theories of heat, electricity, chemistry, and acoustics within the framework of natural philosophy. In regard to Newton's dominance, Cantor shows that 17th-century authors other than Newton put forth corpuscular theories that had some influence, that there was more than one Newtonian optical theory, and that various individuals of the 18th century modified these to suit their individual propensities. With respect to the classification of light theories, Cantor regards their categorization into particle and wave as inadequate for any kind of refined assessment of the situation; there were at least four types of theories: the projectile theory, the fluid theory, the vibration theory, and the wave theory, each of which he examines.

The division between vibration theories and wave theories is critical to Cantor's revision of the assessment of Young and Brougham. The major differences between the theories, according to Cantor, were that vibrationists were concerned primarily with the analogy between vibration in ether and sound in air and were concerned with the ether as an element in a theory of matter, whereas wave theorists concentrated on the mathematical theory of waves, particles, and forces and considered the ether only in terms of mathematically expressible models employed within a hypothetico-deductive methodology. In addition, Young concentrated on the behavior of rays whereas Fresnel developed the subject of wave propagation. On the basis of this fine-line analysis, Cantor concludes that Young was upholding an already rejected "vibration theory" more akin to that of Euler than to the "wave theory" of Fresnel. This rather than the viciousness of Brougham's attacks was the primary reason Young failed to make converts, and Young's law of interference (his true innovation according to Cantor) was initially rejected because his critics, including Brougham, could not abstract the law of interference from the vibration theory because of Young's aphoristic style, which was inadequate for conveying clearly a complex subject.

There can be no doubt that Fresnel was "more modern" than Young. Mathematical physics had come to dominance in France and was coming into dominance in Britain, at least among Cambridge wranglers and British mathematicians elsewhere. Undoubtedly also, mathematics generated a greater reliance on the hypothetico-deductive methodology in physics. But by these standards it was Young's critics who were anachronistic. Most of them were not mathematically oriented, and most of them were skeptical of the hypothetico-deductive approach. Conversely, Young did employ mathematics, albeit inadequately, and to some extent the hypothetico-deductive method. Moreover, Whewell, like other supporters of the wave theory in Britain, was a mathematician, did not view Young as anachronistic, and did not conceive the ether as simply a mathematical model. Who can be said to have "read history backwards," Young's advocates, Young's detractors, or Cantor? Is it possible that Young was simply an

adumbrated Michael Faraday awaiting his James Clerk Maxwell in Fresnel? Here, as elsewhere, Cantor's book raises questions, and that is the mark of a good book.

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European Prehistory

The Prehistory of Germanic Europe. HERBERT SCHUTZ. Yale University Press, New Haven, Conn., 1983. viii, 421 pp., illus. $45.

The aim of this book is "to present a systematic survey of central European cultural history from earliest times to the beginning of the historic period." It describes archeological artifacts, sites, and contexts, and their interpretations, from the earliest traces of human activity in Europe during the Pleistocene until the Romans. Six main chapters deal in turn with the Paleolithic, Neolithic, Bronze Age, Early Iron Age, Late Iron Age, and Northern Iron Age. The book is illustrated with numerous maps and photographs, some in color.

For the general reader interested in learning about the archeology of prehistoric central Europe this is a very useful book. The author discusses the most important sites from each period and puts them into chronological, geographical, and interpretative contexts. Representative tools, weapons, jewelry, and other artifacts from each period are described and illustrated. The author does not shy away from difficult problems of interpretation, and he addresses the significance of such finds as Paleolithic cave art, Bronze Age hoards, and Iron Age bog bodies clearly and sensibly. Footnotes are well handled, and they lead the reader easily to the literature dealing with specific sites and interpretations. The notes are organized at the end and hence do not interrupt the flow of the text. An excellent bibliography of principal works dealing with the topics of each of the six main chapters follows the notes.

The book will not be as useful to professional archeologists, either those working in Europe or those concerned with other parts of the world. The author is not an archeologist but, according to the jacket, a professor of Germanic studies at Brock University, St. Catharines, Ontario. The text does not explore new approaches, methods, or theories. No attempt is made to explain the processes of change in the principal cultural transformations of prehistory—the development of agriculture, of metallurgy, and of towns and cities. Nor are comparisons made between patterns of change in Europe and those elsewhere in the ancient world. The book is too specific to serve as a textbook for most courses on European archeology taught in North America. A vast quantity of data are presented, but they are not organized around central themes.

Repoussé mask and metal cutouts from a wagon from Dejbjerg on Jylland, Denmark, after about 100 B.C. [From *The Prehistory of Germanic Europe*; Nationalmuseet, Copenhagen]

The author relies heavily on published syntheses for the various periods rather than on original site reports, and he often perpetuates models current in earlier generations. The term "culture" is used in a traditional sense (for example on p. 24) with no discussion of the problems of defining cultural entities. Migrations are cited to account for changes (for example on p. 247, on Celts "expanding" in central Europe), whereas most current opinion would suggest other mechanisms. The author's reliance on secondary sources and his only partial direct familiarity with the material permit a number of errors to creep in. For example, the figurine from Petersfels (p. 48) is of jet, not "black amber." The famous gold cup from Fritzdorf (p. 126) dates around 1500 B.C., not 2500 B.C. The spectacular ceramic vessel from Gemeinlebarn with two bulls' heads projecting from the shoulder (p. 138) belongs to the Early Iron Age, not the Middle Bronze Age. Bronze Age settlements are not particularly rare (p. 182). Kromer's notion that the Hallstatt cemetery represented a male-dominated work camp (pp. 204, 206) rather than a family-organized community has been generally rejected as a result of Häusler's important demographic study (1968) of that key site.

"Ritual" vehicle from Strettweg near Judenburg in Styria, after about 700 B.C. [From *The Prehistory of Germanic Europe*; Landesmuseum Joanneum, Graz]