mates by the French zoologists J.-P. and A. Gautier. The most complicated and intrinsically interesting species, the chimpanzee, has been ably treated by Peter Marler and Richard Tenaza.

Some of the information in *How Animals Communicate* will no doubt be outdated in several years, but parts of the book are certain to have enduring value. For example, there will be few other places to find the facts about such endangered and rarely studied species as the snow leopard, the Tasmanian devil, the dugong, the white rhinoceros, and the Hispaniolan solenodon. Full indexes by author and taxonomic group are supplied, the latter taken down to species (providing both scientific and vernacular names), but unfortunately none by topic.

Much of the progress in the study of animal communication has been achieved through a steady expansion of natural history studies, especially in the tropics. These efforts now include a large component of behavioral biology, stimulated by the methods and concepts introduced by ethologists a generation ago. Refinements in experimental technique have been equally responsible for the advance. One striking example is the screening method developed by Wendell Roelofs and his associates at Cornell University to identify female moth sex attractants. Instead of purifying sufficiently large quantities of the pheromone to characterize it by mass spectrographic analysis and other traditional chemical methods, the Cornell researchers use male antennae to scan likely candidates among synthetic products. First a small amount of the natural pheromone is extracted from a few females, chromatographically separated, and roughly classified. Then male antennae are separated and attached to electrodes. When this preparation is exposed to an array of synthetic substances considered promising, the natural pheromone and the most closely related compounds are found to produce the strongest response in the antennal nerve. This method of successive approximation has dramatically speeded the rate of identification. An analogous technique is used by Robert Capranica, also at Cornell, to identify the active components of frog calls. The natural call is first analyzed with respect to spectral structure and wave-form periodicity. Next, synthetic calls are created that vary these qualities, and their effectiveness is measured by the behavioral response of male frogs and the physiological activity of their auditory sensory units.

The major topics of future research on animal communication appear to me to be relatively easily identifiable. They are also technically challenging and as intellectually important as those that attracted biologists during the simpler, pioneering era just ended. They include the effect of specific qualities of the environment—for example, turbulent versus quiet water or dense forest versus grassland—on the transmission properties of signals in each sensory modality; the role of context in the meaning of signals; the sites of the screening process in the sensory and nervous systems by which signal specificity is achieved; the decomposition of complex signals into components of different meanings; the proximity of approach to the optimum design in the evolution of the system, and from this the very meaning of an evolutionary optimum in the case of animal communication; the classification of messages, and the meaning of message in zoology. And—perhaps constituting the grail of this field—the full explication of the differences between animal and human communication, which could narrow the set of pathways along which human language conceivably evolved.

In summarizing our already voluminous knowledge and defining some of the more profitable directions of future research, *How Animals Communicate* is a success. There is still a need for a shorter, more tightly written textbook for students, but as a scholarly review and reference work the Sebeok book will probably be unsurpassed for years to come.

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Changes in Mortality

Mortality Patterns in National Populations. With Special Reference to Recorded Causes of Death. SAMUEL H. PRESTON. Academic Press, New York, 1976. xii, 202 pp., illus. $16.50. Studies in Population.

Despite the fact that death can be handled easily by demographers' methodological tools, empirical studies of the structure and patterns of change in mortality have lagged far behind studies of other demographic processes. Whereas explanations of and theoretical approaches to variations in fertility levels abound, differentials in mortality levels have received little or no attention from demographers. *Mortality Patterns in National Populations* is therefore welcome. It takes a systematic look at mortality patterns across 165 national populations, representing 43 nations at various points in time. The patterns referred to in the title are basically the patterns of mortality by cause of death. The data for all the populations were published in Preston, Keyfitz, and Schoen's *Causes of Death: Life Tables for National Populations* (Seminar Press, 1972). In the book under review Preston presents an analysis of the data that provides us both with some additional tools to be used in mortality research and with some clues to explanations of mortality differentials and trends. He traces out the methodological implications of the cause-of-death structure of mortality better than he traces out the theoretical implications—maybe all demographers do—but his contributions concerning the latter are important if for no other reason than that explanations of mortality differentials supported by empirical data are hard to come by.

Preston's most important methodological contribution is that the analysis and summary of causes of death for national populations result in models of death by cause akin to the models of death by age provided by model life tables. The significance of this work for researchers using data in which statistics on cause of death are more readily available than statistics on age at death is apparent. Preston also provides numerous examples of the use of cause-of-death data in the analysis of mortality differentials. He describes the contributions of various causes of death to age patterns and sex differentials in mortality and the role of various causes of death in producing different levels of mortality in different national populations. Demographers, historians, anthropologists, and others doing mortality research can use the book as a methods handbook and a guide in their own research.

Substantively, Preston addresses "the question that currently seems most central to sociological and economic analyses of mortality . . .: how much of the improvement in mortality levels is in general attributable to improvements in living standards and how much to changes in health levels at a particular standard?" The analysis of the decline in mortality by cause of death is a logical step in finding the answer to this question, since the etiologies of diseases vary and some diseases are likely to be affected by changes in income whereas others are not. In this regard the reader would have benefited from the inclusion of more information than Preston has given about the etiology of the diseases used in the analysis.

Because many of Preston's most interesting substantive findings have to do

with the relationship between mortality levels and changes in economic factors, this book places him in the middle of a controversy that has been raging for some time over the causes of mortality decline. Preston comes to two major conclusions: that the experience of England and Wales between 1851 and 1900 was atypical with respect to causes of death involved in mortality decline and that the mortality declines that have occurred in the 20th century are the result of declines in infectious diseases but the latter declines are not attributable to economic factors. An interesting corollary of the second conclusion is that the infectious diseases, death from which is declining, are not so much well-defined diseases such as typhoid, diphtheria, and measles, the prevention and cure of which have been advanced by Western industrial medicine, as "influenza, pneumonia and bronchitis" or "diarrheal diseases," diseases produced by microorganisms that are diverse and often difficult to identify.

Preston's analysis leaves little doubt that the relationship between income levels and mortality has shifted over time and that factors exogenous to current national income probably account for most of the growth in life expectancy for the world as a whole between the 1930's and the 1960's. Preston leaves the reader curious what these exogenous factors are; if he has any ideas on the matter he seems disinclined to share them with us. Along the same lines, a fuller discussion of the mechanisms by which income levels, which do after all account for some of the decline in mortality levels, affect mortality levels would be quite interesting. Only in chapter 6, where he analyzes the sex differential in mortality, does Preston use other data—for example measures of crowding, data on nutritional levels, and measures of urbanization—to support the conclusions derived from the statistics on mortality by cause of death.

There are obviously many ways in which the data might have been analyzed further, and other readers will no doubt have suggestions for what Preston might have done. In *Mortality Patterns in National Populations* he doesn't tell us everything we've always wanted to know about mortality, but he tells us a great deal and in addition provides us with both the incentive and the techniques needed to answer many of the questions remaining.

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Redirecting Cognitive Science

Perceiving, Acting, and Knowing. Toward an Ecological Psychology. Papers from a conference, Minneapolis, July 1973. ROBERT SHAW and JOHN BRANSFORD, Eds. Erlbaum, Hillsdale, N.J., 1977 (distributor, Halsted [Wiley], New York). xii, 492 pp. $19.95.

Cognitive psychologists have come to realize that many of their paradigms and metaphors lead to a theory as sterile as that based on the bar pressing of the behaviorists' rats. The contributors to this book attempt to counter the sterility by proposing an "ecological psychology" in which the content of an organism's world forms the starting point for the study of its perceptual and cognitive abilities. The strongest feature of the book is its emphasis on the application of environmentally significant theories to a broad range of topics; discussions of perception, attention, child development, motor behavior, esthetics, speech, language, and semantic memory provide the hint of a framework for an ecologically relevant cognitive science. The introduction by Shaw and Bransford sets the scene by discussing the need for a new approach and by describing two additional issues considered in the book: whether perception is direct (not based on memory or inference) and whether there are interrelations between acting, perceiving, and understanding. Although these issues are not explicitly addressed by each contributor, they form a thread connecting the various sections of the book. The individual essays are uneven but basically strong. They are thought-provoking expositions of one view of current problems in cognitive psychology.

My admiration for the book is not without reservation. Perhaps because of the sweeping goal implicit in the book (nothing less than to revise the traditional approach to cognitive theory), the ideas expressed in the chapters seem overly vague, incomplete, and occasionally simplistic. Although the contributors argue that psychology must combine a description of the relevant properties of the world with a description of how these properties are registered by a perceiver, little serious attention is devoted to how, or indeed whether, ecologically significant information is registered.

As an introduction to direct theories of perception, Mace provides an uncritical summary of Gibson's early theorizing. Although the chapter is useful to the reader unfamiliar with this approach, it restricts the definition of an adequate direct theory too much. In laying down five conditions he thinks are essential for a direct theory of perception, Mace unintentionally, I think, excludes potential allies—a questionable practice when one is attempting to revise traditional thinking about the field of cognition.

Fortunately, this exclusionist view is offset by other contributors. Pribram argues that the constructivist and direct positions need not be antithetical; we directly perceive a representation of the world that is a product of the information existing in the organism and that existing in the world. Weimer correctly points out that arguments about direct and constructivist theories are based on omissions by both sides. A constructivist theory must base a representation on available information, and a direct theory must spell out how information is registered and how perception occurs. Merely specifying an ecologically relevant variable results not in a theory of perception but only in an exercise in geometry.

Gibson, in a selection from his forthcoming book, attempts to extend his theory of perception to the meanings (the structural and functional properties) of objects and events. He asserts that there are correspondences between a visual perception and an object's characteristics ("affordances"). Thus, if there is optical information that a surface is rigid, flat, level, and extended, then the surface affords "sit-on-ableness." In similar fashion, events may "afford" nutrition or poisoning. The problem with this view, which puts the meaning of objects and events in the nature of visual stimulation, is that it doesn't demonstrate, but only postulates, the existence of "affordances." It is an interesting hypothesis, but one that as yet has no empirical support.

A chapter by Shaw and Pittenger summarizes their research showing that a geometric strain transformation of facial profiles provides information about age while preserving individual identity over age. This is an important demonstration of invariants in visual form perception, especially since Shankweiler, Strange, and Verbrugge point out in their chapter that attempts at similar demonstrations in speech perception have not been fruitful.

Chapters by Turvey and by Weimer marshal the arguments regarding the interdependency of behavior, perception, and comprehension. One wishes the chapters had more specific suggestions about the nature of visual motor integration. Turvey discusses the physiological underpinnings of a general control theory of vision but gives little attention to how such a theory might be