the apparatus of probability-generating functions or Laplace transforms is used to derive even the most elementary results, apparently on the theory that if the reader can be trained to hold his seat on the easy rides he has a chance to hold it through the tougher rides encountered elsewhere in the book.

The authors' decision to restrict themselves to a certain core set of mathematical techniques and to limit themselves to substantive problems capable of being efficiently treated by these techniques results in uneven coverage. Methods based on differential equations or generalized, age-dependent branching processes are ignored. Despite its important contributions to the investigation of family building, microsimulation is neglected except as an occasional source of numerical illustration of points derived analytically. The detailed treatment of fecundability is nowhere balanced by a close consideration of the variables of gestation, anovulation, reproductive length, or competing pregnancy outcomes. This asymmetry is awkward because the last six chapters deal with pregnancy and birth intervals whose behavior depends as much on these other aspects as on fecundability. In fairness, however, it should be observed that the book's unevenness simply mirrors the unequal development of these topics in the literature.

A basic work for any investigator interested in the mathematics of human reproduction, the present volume should also appeal to the general scientist who is looking for additional examples of nontrivial applications of probability theory to basic human issues.

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Ethology Today

Perspectives in Ethology. P. P. G. BATESON and PETER H. KLOPFER, Eds. Plenum, New York, 1973. xiv, 336 pp., illus. $17.50.

The publication of this book was most timely, being nearly coincident with the awarding of the Nobel Prize to Konrad Lorenz, Niko Tinbergen, and Karl von Frisch for their development of the field broadly known as ethology. In some circles the term ethology is more narrowly applied to the theoretical framework erected by Lorenz and Tinbergen to account for the freely occurring behavior of animals. Both these men set great store by descriptive studies, and both organized their findings around the principles of Darwinian evolutionary biology. Consequently heritability became an important issue and was embodied in such concepts of perception as releaser and releasing mechanism. The stereotyped responses of animals also were regarded as genetic in origin, with the units or chains of behavior being products of highly specific drives. But since evolution also demands adaptation at a more immediate level, the door was swung open for the environment, as witnessed by the elaboration of concepts such as imprinting and the interlacing of instinct and learning.

The ethological view of behavior evoked a vigorous response and virtual condemnation from some other investigators of animal behavior, such as T. C. Schneirla and his student D. S. Lehrman. Some have labeled this group environmentalist, but if such simple labels must be used I prefer to call them developmentalist. Likewise some have characterized the ethologists as instinctivist, though I think they are more fairly described as phyleticist.

There followed a long and often confused argument between these groups, turning mainly on the durable nature-nurture issue. One view is that this debate has been injurious and obfuscating. I believe, on the contrary, that it has been beneficial to all concerned and that its ramifications will continue for some time.

With Tinbergen and Lorenz now joining von Frisch in retirement, it seems appropriate to assess the state of ethology today. Obviously the field has changed enormously since the 1940's and '50's when many of the central themes were laid down. Now one does well to ask Who is an ethologist? It is difficult to say. The scope of the field has increased with its popularity, for more practitioners mean more division of topics and more points of view. And the boundaries between it and other fields have been fading as earlier ideas change, disappear, or develop into fields of their own. The distinguishing feature of an ethologist remains a focus on naturally occurring behavior. Yet many who count themselves ethologists work under laboratory conditions strict enough to please the most demanding experimental psychologist. Most of them have never systematically observed their animals in the wild or even under simulated natural conditions, but still they are making meaningful contributions dealing with the problems traditionally of importance in ethology.

A reading of *Perspectives in Ethology* will not completely satisfy any felt need to know where ethology is headed today, although the reader will make progress in that direction. The book samples a wide range of topics. It illustrates both the breadth of the field and, for better or for worse, the current state of thinking on some of the problems of more enduring concern. In fairness one should note that it was not the editors' intent to provide an overview of ethology. But their motivation comes from an appreciation of the historical development of ethology. They recognize that after a period of theoretical flowering there had to follow a phase of consolidation and quantification. Their aim is now to encourage new or controversial theories, even at the risk of relaxing requirements about substantiation. To this end they invited several contributions; they received some unsolicited ones as well.

A number of the articles are concerned with the organization of behavior, for example with its causation or motivation. Among these, the chapter on sequences by P. J. B. Slater is representative of quantification and consolidation in ethology. In a more theoretical vein, and after a thoughtful introduction, M. J. A. Simpson reflects at length on the inadequacies of existing models dealing with social organization. He establishes that they are often simplistic and can be misleading, and points to the need to consider individuality and the history of social relationships.

The article by Keith Nelson is a delightful romp across partially new vistas as he declares himself full-out for holism. It is a refreshingly open and chatty article about some difficult problems of detecting organization in behavior. Nelson uses as a springboard

the complex songs of thrushes. Analysis is at several levels, and he breaks away from the more conventional approaches. In reading the article I worried a bit that I was being led up the garden path. His manipulation of data stirs memories of circadian rhythms in unicorns, but I would like to believe his analysis. Nelson goes on, building more general input-output models, and attempts to relate this to arguments about whether behavior is hierarchially or distributionally organized.

The article most in the mainstream of ethological thought on the organization of behavior is that of J. C. Fentress. He brings together a divergent literature on the problems of "action-specific" control versus "nonspecific" activation. The result is an esoteric collage, at times stimulating, at times recondite, and always difficult to decode. I suspect that the use of verbal models in motivation studies may have seen its day. More clarity might have been achieved here through the application of explicit mathematical models to cut through the mass of seemingly contradictory findings, as has been done in some other motivational studies in recent years.

The experiential dimension emerges in two of the more interesting chapters. One, by J. Garcia, J. C. Clarke, and W. G. Hankins, reexamines stimulus-response theory in relation to ethology and to paradoxical findings in experimental psychology. This article is something of a culmination of a growing dissatisfaction manifested in the psychological literature with the simplistic assumptions of the S-R model. The authors propose as an alternative an "information theory" of learning (an unfortunate choice of terms since information theory is so widely understood to refer to communication). This essay is as remarkable for its sophisticated arguments about learning as it is for its uncritical acceptance of ethological theory. The other chapter on experience, by J. M. Davis, is a useful review of imitation, establishing the importance of the phenomenon and revealing, by contrast, how remarkably little it is studied.

I was surprised that only one chapter deals directly with what must be ethology's most rapidly growing and potentially most important area: behavior as a mechanism in ecology. J. R. Krebs has written a lucid and parsimonious review of behavioral aspects of predation. The focus, however, is more on the strategy of searching than on overt behavior. Decisive treatment of various models points the way to further profitable research.

Almost as if to remind one that ethology also includes orientation, a timely brief article is included on magnetic orientation by birds. There is a growing body of evidence that birds use geomagnetic clues in migration. The author, S. J. Freedman, is a physicist who understands geomagnetic fields. He describes in a few words how birds *could* use such information for navigation. The problem of receptors, however, remains.

This book is most welcome. I applaud the goal of the editors, and I am delighted to see that they hope this will be just the first such book of a series. They intend to maintain a forum for ideas, including unpopular and heretical ones. To that end they solicit and welcome manuscripts. I should like to remind them, however, that editorial intervention can be done without the suppression of ideas, and indeed is often called for. For it is as reprehensible to publish an article that will not be read because it is poorly written as it is not to publish the article at all. The chapters in the second half of the book, for example, are altogether too long, and the first of them would have benefited from constructive editing.

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Neuroethological Approach to Animal Learning

Constraints on Learning. Limitations and Predispositions. Proceedings of a conference, Cambridge, England, Apr. 1972. R. A. HINDE and J. STEVENSON-HINDE, Eds. Academic Press, New York, 1973. xvi, 488 pp. $18.50.

Robert Hinde's introductory chapter to this book sets the stage by presenting two very different approaches to animal learning. One view, embodied in the work of psychologists such as Tolman, Skinner, and Hull, holds that there exist "laws of learning" of considerable generality and precision. The data base for these general laws is derived from a few intensively studied species learning arbitrary tasks under rigidly controlled conditions. The countervailing view of ethologists such as Tinbergen and Lorenz is that learning ability, like any other biological characteristic, has been shaped and sharpened over evolutionary time to serve in many cases quite specific ends. A particular species may learn one task very well and show no sign of learning in other situations, or two species in the same genus may show opposite results when presented with the same task to be learned. Hinde's introduction indicates the variety of factors that can operate to determine what is learned.

The remaining chapters of the book provide numerous examples of specialized learning mechanisms and factors that constrain what is learned in vertebrate species. Baerends and Kruijt analyze the responses of the herring gull to its eggs, especially the physical aspects of the stimulus controlling egg retrieval. They show quite clearly that different stimulus properties of the egg are used in triggering different responses. In their words, "physically identical stimuli may be evaluated differently by an animal, according to the activity they are controlling."

C. Blakemore summarizes recent work on the effects of visual experience on the trigger features of visual cortical neurons. In the kitten as little as 33 hours of selective visual experience can markedly alter the response properties of cortical cells, which then constrain the range of stimuli to which the animal subsequently attends. These considerations lead naturally to a discussion of imprinting in birds by P. P. G. Bateson. The effectiveness of visual stimuli both in altering the response properties of kitten cortical neurons and in promoting approach responses and social attachments by precocial birds is limited to a critical period very early in development. Bateson explores in detail how newly hatched chicks learn to recognize food, documenting the existence of critical periods and long-delay associations in this type of learning.

Taste-aversion learning in mammals and birds is one of the most striking examples of a specialized learning mechanism which is at variance with the psychological "laws of learning." This type of learning, discussed by D. J. McFarland, can occur with delays of reinforcement of several hours, is resistant to disruption by electroconvulsive shock, and can occur when the animal is given the reinforcement while in deep surgical anesthesia. Mc-