

the leaders of major governments about the actions of foreign countries comes to them through their intelligence agencies. The filtering that takes place as the information passes through these channels crucially affects the impact which the words and deeds of one country will have on another.

Since intelligence agencies share the failings of any bureaucracy, there is likely to be substantial distortion in the signal received. In fact, it is doubtful whether one can really understand the dialogue between nations without a thorough (and hence essentially impossible) study of the operation of intelligence agencies as analytical and information-processing organs for national leaders. Even in the absence of detailed knowledge of this process, one generalization is probably safe: It is unlikely that the interposition of intelligence agencies between the leaders of one country and those of another will facilitate a change in the attitudes of either country, or enhance the chances for "strategic persuasion."

If the dialogue between nations has all these limitations, what can be expected from it in achieving some measure of arms control? Undoubtedly, very little. The arms race is fueled by pressures to procure the weapons emerging from well-financed military research and development programs. If there is to be a significant limit on armaments, each government must act on its own to resist these pressures. Thanks to improvements in intelligence-gathering techniques (primarily through the use of space-borne detectors), there is now sufficient information available to each side to permit such unilateral restraint.

This opportunity for restraint is particularly clear in the case of the United States, which is, by a large margin, the dominant military power in the world today and the one most able, if it wishes, to retard the arms race through its own actions. At every stage in the arms race, as new technology has been introduced, we have been leading the way—as Jerome Wiesner has commented, we have been running an arms race with ourselves. Eventually the Soviet Union matches whatever new weapons development we have undertaken, but the pattern of U.S. "leadership" in the arms race seems clear, from the introduction two decades ago of the intercontinental bomber to the current emphasis on missile penetration aids and multiple warheads.

The United States has recently de-

cided to construct a ballistic missile defense, proclaimed in a series of official speeches as a defense against Chinese attack. It is declared to be no threat to the Soviet Union since, while taking this step, we still hope to avoid a new and costly round in the Soviet-American arms race. However, it is questionable indeed whether the Russians will take our assertions at face value, or whether they can afford to wait until the system is deployed to decide if they must respond to it.

If we do want to restrain the arms race, we cannot assume that the dialogue will be effective and that our messages will be received and understood in the way we intend. Rather than rely on the Soviet Union to perceive our signals accurately, we would be far better advised to rely on our own unilateral restraint to prevent a costly and dangerous offense-defense race. While a formal treaty to accomplish this is only a remote possibility, and restraint through dialogue seems only a slender hope, arms limitation through unilateral restraint and United States leadership could, if we willed it, become a real possibility.

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## Mechanisms of Behavior

**Instinct and Intelligence.** Behavior of Animals and Man. S. A. BARNETT. Prentice-Hall, Englewood Cliffs, N.J., 1967. xiv + 224 pp., illus. \$6.95. Prentice-Hall Series in Nature and Natural History.

The rediscovery of the world of animal behavior by 20th-century biologists and psychologists has given rise to a considerable number of technical books. The field of study is vast and diverse, and new enough in its relation to modern biology that our understanding of the phenomena which it encompasses is quite rudimentary. Such a state of partial understanding is most conducive to book writing. Far from being objectionable, this state of affairs has a salutary effect on a developing field. In time, as natural selection operates in the world of books, there will undoubtedly emerge a small number of definitive works. In the meantime, the interested reader is presented with a smorgasbord of volumes each of which has something different to say, each of which reflects the prejudices of its author more starkly

than might be expected in a more mature discipline.

Inevitably the words "instinct" and "intelligence" appear somewhere in each of these books. The terms are so fraught with potential misunderstanding and prejudice that it requires a measure of courage to employ them, as Barnett has done, in a title. As a matter of fact he apologizes in the preface and hastens to say that he does not use them as technical terms with precise meanings. He goes on to remark, however, that they do denote topics of study, that the phenomena comprehended under these headings are real. The phenomena to which he refers are species-specific action patterns and drive on the one hand and adaptable behavior on the other. In the sense that all behavior falls somewhere within this broad spectrum the title is apt, and it enables laymen (for whom the book is intended) and professionals alike to form a correct idea immediately of the subject matter of the book even without the subtitle to guide them. Except for accounts in three short chapters toward the end, the concepts of instinct and intelligence are not dealt with directly.

The principal theme is the analysis of behavior by experiment. It begins with a statement of the problem: What are the mechanisms of behavior? Of what use to the individuals or species is the behavior? Barnett warns briefly that one must take account of other species (other than man, that is) as they actually are, not impute to them cleverness that they lack yet not deny them their true, remarkable abilities because we see them as possessing only our kind of senses. This introduction leads into a very brief mention of nerves, senses, and stimulus and response, and the observation that animals have in common the ability to move about. From here the discussion flows naturally into considerations of taxes, kineses, migrations, search, and exploration. Sixty-five pages are now devoted to the subjects of herding, dispersion, threat, submission, peck orders, social stress, courtship and family, social insects, communication and society. A succeeding short chapter on heredity and environment suffers from being too succinct for the breadth of the subject and the subtlety of the arguments presented—seven pages cover Darwinian and Lamarckian accounts of the evolution of behavior, the problem of Nature and Nurture, and the meaning of the word "inherited." It is doubtful that the average reader will be able to appreciate the distinction between in-

heriting "behavior" and inheriting "differences" in behavior. Indeed, as the author says, there is involved here a fundamental question that is a source of much confusion even to biologists themselves. The treatment will not help resolve this confusion.

A direct discussion of instinct begins on page 119. It deals essentially with two aspects of behavior: species-specific fixed action patterns, and drive (impulse to act). Many fascinating examples of the former are given. The point is made that there is no hard and sharp distinction between innate and learned behavior. Clearly there is some development. Examples are taken from the singing of birds, imprinting, and Harlow's experiments on early social development of the rhesus monkey. The general impression given is that so-called instinctive behavior is less firmly predetermined than it seems to be. The author argues, using as an example the repair of damaged wasp nests, that much of the stereotyped behavior is not mechanical as some experimental analyses might lead one to believe.

Studies of feeding behavior in the blowfly and in mammals provide examples of the experimental analyses of drive or motivation. The author points out initially that "feeding is a better term than hunger," but by the time the mechanisms have been described in both cases the story essentially reverts to the semantics of hunger and whether one is dealing with a sensation, a colloquial term, or multiple drives rather than a unitary one. The discussion of the drive to action concludes with comments on emotions, descriptions of the experimental work on self-stimulation, and experimental neurosis.

Intelligence is treated according to its dictionary definition of "the ability to adapt behavior to circumstances." The examples of adaptable behavior given include trial-and-error learning, conditioning, habituation, reward and punishment, teaching, and imitation.

A chapter entitled "The sources of human behavior" treats of other primates, with descriptions taken especially from the work of Schaller on the mountain gorilla and Kortlandt and Goodall on the chimpanzee. A few paragraphs on man's evolution follow, and the book concludes with three pages on the science of behavior in which the concept of voluntary behavior and the idea of mind are mentioned. The happy thought of identifying, directly rather than parenthetically, various aspects of experi-

mental work with the people who have done it removes the dry impersonality that characterizes so many books on science. The frequent admission that "we do not know" also brings life to the subject and tends moreover to lend added weight and authority to the positive statements.

There are moments when the book seems overly involved in semantics. The author obviously finds some words acceptable (for example, "instinct" and "intelligence") and others not. "Threat" and "submission" are acceptable; "aggression" and "appeasement" are not; "hierarchy" is on the unacceptable list because of its etymology. Some words end up in quotation marks (for example, "retrieve"), while others (such as "forage") do not. The whole business quite naturally reflects an author's personal tastes.

On the other hand, the erudition and critical appraisal that are brought to this work give it great integrity. The errors of fact are few. (The observation that

male moths are attracted to female from as great a distance as two miles has been accepted uncritically from the original literature, and the statement that most animals in nature are healthy is certainly open to challenge.)

For those who wish to satisfy a curiosity about animal behavior this is indeed a refreshing, authoritative, and provocative book. It is rich in examples. Barnett's vast knowledge of the field of behavior enables him to draw his descriptions from all phylogenetic levels so that one is left with a sense of the wholeness and integrity of the animal kingdom and its behavioral binding forces. Including man in the story, neither exalting his uniqueness nor denegating it, gives logical completeness to the story and at the same time imparts the relevance to events that some people require of their science.

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## Mathematics in Astronomy

**Introduction to Stellar Statistics.** RUDOLF KURTH. Pergamon, New York, 1967. viii + 175 pp., illus. \$8. International Series of Monographs in Natural Philosophy, vol. 10.

The phrase "stellar statistics" can be interpreted in two ways. On the one hand it can imply the theory and methodology of statistics and probability which are applicable to problems of astronomy. Or on the other hand it can mean the astronomical knowledge gained by studies of the distribution of stars and galaxies by statistical methods. The author of the book under review adopts the first interpretation. The book is essentially mathematical in character. Applications to astronomical problems are not carried out in detail. As the author writes, he has tried "(i) to provide the student not so much with details of knowledge but rather with some kind of conceptual system of reference which may help him to organize his knowledge; (ii) to hint at problems which, in my opinion, deserve a re-examination." It seems to the reviewer that the book would serve more valuably to introduce a mature statistician to some of the astronomical applications than to assist a student of astronomy who is attempting to establish a satisfactory statistical base for

his knowledge of the stellar system. It would not be a particularly suitable textbook for a class in statistical astronomy.

In addition to a discussion of the elements of probability, statistical distributions, and tests of hypotheses, the book contains a chapter on the integral equations of stellar statistics. The author has used his own unique vector nomenclature throughout. The emphasis is on mathematical rigor, and several new procedures are introduced.

Applications of statistical techniques and descriptive parameters have been discussed for distributions of stellar brightnesses, stellar motions, galaxy distributions, stellar distances, and the like. No numerical examples are given, and the relation of the statistical description to the real universe is somewhat obscured by mathematical detail.

Three appendices give a list of suggested research problems, a discussion of quadratic forms on the unit sphere, and some recent results on the distribution of stellar velocities. The book concludes with a valuable list of references.

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