Reading Animal Minds

Herbert L. Roitblat
Introduction to Comparative Cognition
New York: Freeman, 1987. 377 pp.
ISBN 0-7167-1778-6 (hardcover);
0-7167-1777-8 (paperback).
$29.95 hardcover; $17.95 paperback

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The study of animal behavior in psychological laboratories has changed its emphasis during the past decade or so, and Roitblat's book has chronicled that change cogently and clearly. In the introductory chapter, he argues with some zeal that experiential change of any kind, either reflexively based or more complex, is a representation that transmits information from one time to another. "Reflex- and reinforcement-based explanations suggest one kind of representation an organism might use. They are not alternatives to the concept of representation" (p. 19). Many of us, like Roitblat, have developed a new set of heuristics and are reading animal minds instead of reading cumulative records. How did this come about?

There are many demonstrations illus-

trating goal-directed thinking in animals that do not fit the notion that animals respond mechanically to stimuli. For example, rats taught to run a maze can then swim it correctly after the maze has been flooded with water. Swimming requires different muscle units than running. Conversely, sea lions taught to touch their tails or their flippers to objects in water show immediate transfer when signaled to respond to the objects on land. In a size transposition experiment, where a small object was removed and the previously designated large object was paired with an even larger one, a sea lion showed by its choices, searching patterns, and reaction times, that its behavior was first controlled by the absolute size of an object and then by the relative size of the object. To explain at least *some* aspects of these animal behaviors (cognitivists like Roitblat would say *all* aspects), we are compelled to refer to a code, representation, or some other mental state to define the stimulus and to an intention or goal to define the response.

Reading animal minds, or finding a window into their inner world, depends principally on observing the consequences of mental activity. How do mental events affect an animal's performance? Concept-driven or sensory-driven processing is studied by observing the kinds of decisions and errors animals make in a variety of detection and discrimination tasks. Mental imagery is investigated by observing the time it takes an animal to make certain judgments about stimuli in some types of conditional discrimination tasks. To determine what kinds of social knowledge animals have, conspecific acoustic signals are played to them, and their reactions are observed. In this way, we determine an animal's ability to recognize, classify, and remember foes, friends, and family. Furthermore, artificial and simplified languages are being taught to dolphins, birds, and sea lions, as well as to apes. These interspecies communicative studies help determine not only whether rather diverse taxa have the basic intellectual skills indicative of language processing, but they also serve as a way of investigating the knowledge animals possess about their world.

As they say on *60 Minutes*, "all this and more" is covered in a text of 377 pages, which includes clear and effective illustrations and tables, plus seven pages of very helpful notes and over 500 references of which about 25% have been published since 1980. Roitblat has indeed kept abreast of the literature on human and animal cognition.

After defining the subject matter of comparative cognition as the study of structures, processes, skills, and representations intervening between experience and behavior and following a comprehensive, clear, cogent, and concise historical rooting of the field, Roitblat uses most of the book (173 pages and half the chapters) to explore the methods, theories, and data on stimulus control, classical and operant conditioning, short-term or working memory, and sequential and temporal discrimination. On the issue of stimulus control and attention, he uses an exquisite combination of animal and human experimentation to describe how the subjects of these experiments show (a) systematic presolution response patterns, (b) improved successive reversal-performance, (c) positive transfer from a simultaneous to a successive discrimination, (d) better transfer on intradimensional than extradimensional shifts, (e) blocking and overshadowing, and, finally, (f) improved performance as a function of "cuing." From such findings, he justifiably concludes that animals actively learn which stimuli are informative and which are not and that attention cannot be equally allocated to separate stimulus dimensions. In the chapter on working memory, Roitblat relies on his own seminal work as well as that of others in the field to deal with a key issue in animal cognition—the nature of the memory code. Do animals store information about anticipated signals ("prospective coding") or about preceding signals ("retrospective coding")? The answer seems to depend on the nature of the task and perhaps the species as well. Rats given a 15-min delay following even-numbered choices (2 through 10) in a 12-arm radial maze remembered best those arms they had visited before the sixth choice (retrospective memory) and those arms remaining to be visited after the sixth choice (prospective memory). Thus, rats use either type of memory code depending on which is optimal. Pigeons, in a delayed "symbolic" match-to-sample task, on the other hand, were more likely to retain information concerning the features of the anticipated choice stimuli (prospective memory) than about the preceding conditional cue (i.e., the sample stimulus). Thus, the working memory of pigeons, according to Roitblat, "contains a gradually strengthening representation of the choice the animal will make at the end of the retention interval" (p. 188).

Concepts that animal cognitivists have borrowed from information theory, computer programming, and the study of human memory include information processing, hierarchical control, mental representations, short- and long-term memory, chunking, rehearsal, and so forth. Several such concepts from the study of human cognitive processes are being increasingly adopted by behavioral ecologists, ethologists, and sociobiologists studying foraging, social living and communication, predator avoidance, imprinting, song learning, and so forth. These investigators assume that animals have evolved foraging and social living skills along with the ability to acquire and retain information about their environments. They further assume that animals use such information in making fitness-maximizing decisions. These topics are taken up in Chapter 7, "Cognition and Natural Behavior," which first deals with the role of memory, searching images, and generalization in foraging strategies, primarily of birds, and then considers symbolic reference in the communication of honeybees and vervet monkeys.

Finally, in Chapter 8, Roitblat considers an area of animal cognition—animal language research—which, in addition to casting some heat on the matter, has also shed considerable light on our notions of language in relation to thought and uniqueness of language in humans. He concludes that the studies of language training with apes, an African grey parrot, dolphins, and sea lions indicate that the kinds of tasks these subjects are mastering tap cognitive capacities that are widespread in the animal kingdom. These include the learning and retention of paired associates, acquirement of concepts and representations of objects, properties of objects and actions, and the learning of rules rooted in conditional sequential discriminations and serial memory.

Perhaps it is really the subject matter of another book, but I think with "comparative cognition" in the title, Roitblat owed at least the comparative psychologists in his audience some discussion of the issues involved in studying the evolution of mind or information-processing capacity as related to brain–body size. He states quite emphatically at the outset that this is "not a book on comparative intelligence in different species" (p. xii), because he believes the questions about animal intelligence are too confounding. The current dilemma of animal intelligence study derives from suggestions that intelligence is constrained or facilitated by specializations related to "ecological niche" considerations or that it is task dependent and, therefore, cannot be mea-

sured directly along any "simple dimension." But Jerison has argued persuasively that random variations may lead to advances in mental capacity (Jerison, 1982), and measurement techniques of internal representations in animals are becoming increasingly sophisticated as Roitblat himself points out. Progressive or anagenetic evolution seems to have occurred with regard to several quantifiable traits, such as size, weight, or speed of locomotion. Therefore, Jerison's "encephalization quotient," or EQ (i.e., the quantity and quality of information a brain can compute over and above that required to control routine bodily functions), seems to be a valuable concept. EQ looks broadly at the correlation between the evolution of increasing neural complexity and what Shepard has called "an increasing internalization of regularities of the world" (Shepard, 1987, p. 259). An illustration of exquisite information processing is the capability of an animal to do cross-modal perception.

However, my complaint should be considered mild. This is but one small weakness in what is, by and large, the single most unified and comprehensive textbook yet written on the subject of comparative cognition. The book deserves careful reading by all experimentally oriented psychologists, and it should be extremely enlightening to those working in the field of cognitive ethology.

References

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