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Preface: Animal Cognition in Nature

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Preface: *Animal Cognition in Nature*

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This volume, *Animal Cognition in Nature,* is the result of an ongoing synthesis of several ideas that were considered revolutionary, if not heretical, in the 1960s. At that time, animal behavior, whether studied in field or laboratory, by ethologists or psychologists, was generally interpreted as the result of simple processes relating specific stimuli to specific behaviors. Examples from that time include S–R models, sign stimuli, IRMs, etc. Theoretical constructs such as mental representations, memory or attention were avoided. Today, students of animal behavior work in an entirely different atmosphere. This is the result of several developments.

One of these developments was the aptly named "cognitive revolution" among psychologists which inspired researchers to adapt the cognitive stance and test a wider range of behaviors, revealing many previously unexpected abilities in their subjects. Simultaneously, behavioral ecology appeared, with a whole set of novel concepts such as optimization models, sociobiology and kin selection. In addition, results from fields as diverse as social communication, navigation and neurobiology suggested that animals remember, process and store large amounts of complex information that allows them to predict outcomes in a variety of situations and thus solve a striking range of problems. For example, two of the editors of this volume have worked on spatial memory in seed-caching birds. In order for long-term spatial memory to occur, an animal must first transform spatial information into some type of neurological code (or representation). This must then be stored, remaining intact in memory for some length of time. Later, this information must be retrieved from long-term memory, decoded and translated into appropriate behavior. This is an example of how cognitive systems involve complexes of neurological and behavioral characteristics. We have long since left the realm where animals are viewed as simple, stimulus-bound responders, passive learners or robotic followers of conditioning regimes.

As we invited the authors of the chapters that constitute this book to participate, we challenged them to approach their research programs from a cognitive

perspective. In some cases this required the authors to take an approach that was very novel to them. The reason that the cognitive approach is so novel to many scientists interested in animal behavior can be found in the history of the study of cognition in animals.

Almost a century has passed since scientists first developed concepts, definitions, and experimental paradigms about what would now be called animal cognition. These early studies and ideas were mostly limited to the domain of the experimental psychologist. Cognition consequently was studied in a limited number of species of laboratory animals by scientists looking for homologies to human behavior. Such studies considered neither the ecological setting (or lack thereof) in the laboratory nor the evolutionary history of their subjects. This lack of ecological and evolutionary reasoning often led such studies to seem inappropriate and irrelevant to biologists, who, not surprisingly, tended to ignore the studies. This, we believe, was unfortunate. Even if these experiments seemed to occur in a biological vacuum, the cognitive processes being uncovered by these studies were of fundamental biological importance.

Fortunately, many of the theoretical and empirical problems of the modern study of animal behavior are of great interest to both psychologists and biologists. This has made it relatively easy for concepts and ideas to cross disciplinary boundaries. For example, the results of early studies in behavioral ecology showed that animals are capable of a diversity of adaptive responses to changes in their natural environments. Such complex responsiveness to stimuli is a hallmark of cognitive abilities, and a number of cognitive theories from psychology could be appropriately applied to explain these behaviors.

The growing realization that cognition should be viewed as an evolutionary trait is leading to a paradigm shift. Ecologists, ethologists, and field biologists are beginning to realize and accept the idea that in many instances they are observing, recording, and studying the results of the cognitive abilities of their species. When a new and unique point-of-view is brought to bear on a discipline for the first time, unexpected and stimulating ideas emerge. When disciplines interact and begin to share facts, ideas, methodologies and hypothesis, new interpretations and theories are formulated. These fresh, new viewpoints may be so utilitarian that they are immediately incorporated into existing research programs. The areas of behavioral ecology and comparative psychology offer such a potentially dynamic mix. To some extent, this integration is already occurring. Biologists are beginning to recognize and appreciate that cognitive considerations may playa pivotal role in resolving some problems in field research and natural history. Psychologists are becoming increasingly aware of the importance of ecological and evolutionary factors in determining the nature of cognitive abilities.

As a result of this state of affairs, a number of different books, including this volume, are beginning to appear or are scheduled to appear soon. These books, as well as a number of review articles in major journals, will set the direction of

study for the interdisciplinary study of animal cognition in a simultaneously evolutionary and psychological framework. Although the name "Cognitive Ethology" has been suggested (in this volume) for this new subdiscipline within the Life Sciences, other labels may be just as appropriate. Only time and a spirited dialogue by the participants will resolve the issue. Nevertheless, a new approach is certainly emerging. In putting together this volume, we have used a unique strategy, emphasizing the importance of the study of cognition either under natural conditions or in light of known natural history phenomena.

The authors view cognition as an adaptive trait, shaped largely by the influence of natural selection much as morphological and physiological traits have been so shaped. Cognition is part of the adaptive arsenal with which animals cope with environmental demands and constraints. If this is so, then information-processing abilities must be understood as adaptive traits. This view accepts the idea that the quality and quantity of information an animal has about its environment and neighbors (both conspecifics and others) will be translated into the biological success of the animal. Individuals with varying amounts of information should show differential fitness just as occurs with other biological traits.

In constructing the content of this book, the editors attempted to explore systematically some prominent areas of animal behavior in which cognition most likely plays a dominant role in natural settings, and could be employed to explain the complexity of observed behaviors. Three of the areas in which this integrative approach is proceeding rapidly are animal communication, seed caching and recovery and navigation and orientation. There are also a number of domain-specific cases that are not yet as clearly conceptualized, but hold great promise for future research. These considerations led us to invite a set of leading researchers to participate in this project. Authors of each chapter were challenged to present their most contemporary data, discuss their data in a cognitive framework, considering what advantages and disadvantages such a framework might offer and address potentially fruitful areas of future research within a cognitive perspective. We hope that the resulting volume contributes towards the next generation of integrative research on animal cognition.

About the editors

Russell Balda spent over 20 years studying the natural history, population dynamics, sociobiology and seed-caching behavior of the highly social Pinyon Jay. His years of experience with individually banded (ringed) birds led him to conclude that problem resolution in a social animal requires highly developed mental skills. While observing Pinyon Jays and nutcrackers cache and then recover seeds with high degrees of accuracy he became impressed with the spatial abilities of seed-caching birds. These two areas of interest led him to recognize the importance of bringing these birds into the laboratory for highly controlled experiments. He has cooperated with A. C. Kamil on questions pertaining to spatial abilities, the evolution of cognition and its selective environment for the past 17 years. He is keen on finding natural history traits that indicate cognitive abilities and then attempting to study them in the laboratory. Presently, he is studying the different cognitive abilities of social and asocial jays and sexual differences in spatial memory in Pinyon Jays.

Irene Pepperberg has spent the past 20 years examining the cognitive processes of parrots and the effects of social interactions on vocal learning. Her cognitive studies demonstrate that the capabilities of birds match those of the great apes and marine mammals; her studies on social learning demonstrate intriguing parallels between human and avian vocal development. Her current focus is on the synthesis of these two areas of behavior, and on proposing how this synthesis might provide insights into behavior observed in the field.

Alan Kamil has been a leader in the effort to bring cognitive mechanisms implied by field observations into the laboratory for detailed experimental analysis. He has clearly defined the pros and cons of this approach in a number of provocative articles. Early in his career he found that Blue Jays were capable of complex strategy learning comparable to that found in primates. This led him to consider the implications of cognition as an adaptive trait. Groundbreaking studies included developing a methodology for studying search image in the laboratory and strategy learning in nectar-feeding birds in the field. He and Balda have worked together in an exhaustive series of studies on spatial memory in seed-caching birds. He is presently working on complex geometric learning by seed-caching birds and the effect of cognitive abilities of predators on the evolution of prey appearance.