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The Cognitive Animal

Empirical and Theoretical Perspectives on Animal Cognition

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Introduction

There are as many approaches to studying animal cognition as there are definitions of cognition itself. This diversity is reflected in the essays that follow, to a degree that we believe is unparalleled in any other volume that has been produced on this subject. This diversity is philosophical and methodological, with contributors demonstrating various degrees of acceptance or disdain for terms such as “consciousness” and various degrees of concern for the rigors of laboratory experimentation versus the validity of naturalistic research. The diversity is also apparent in the wide range of species to be found between these covers. Of course there are many chapters on primates, and especially the great apes, reflecting our human-centered interest in our closest relatives, but there are also chapters that touch on cognition in animals as diverse as earthworms, antelopes, dogs, spiders, dolphins, bees, fish, hyenas, snakes, sea lions, prairie dogs, virtual organisms, parrots, rats, ravens, and squirrels, to name but a few. We think we have produced one of the most wide-ranging menageries of scientific studies of animal cognition ever assembled. Yet it is humbling to realize that in terms of the diversity of life itself we cannot claim to have even scratched the surface.

One of our objectives in bringing such a diverse collection of research studies together is to show that whatever the ideological differences, behavioristic psychologists and cognitive ethologists have a lot to learn from each other and from the neurosciences. Yes there are differences of opinion about how to pursue the study of animal cognition, but all sides stand to gain from listening carefully to the concerns of others. Despite the differences, there is in fact a great deal of similarity among the different approaches, for they have, after all, evolved from the same starting point in the theory of evolution by natural selection.

The roots of both comparative ethology and comparative psychology are found in the writings of Charles Darwin, particularly in the *Origin of Species* (1859), *The Descent of Man* (1871),

and *The Expression of the Emotions in Man and Animals* (1872). Consequently, both disciplines are almost inextricably linked to the concept of instinct. Darwin viewed instinct primarily in behavioral terms and considered his ability to explain instinct through natural selection to be one of the most critical tests of his theories. Thus he compared closely related species of bees to explain the evolution of hive building and closely related species of ants to explain the origins of slave making. He also focused on domesticated species to show how human intervention and selection could have formed variants. His prime examples here were different breeds of dogs and pigeons. Soon, zoologists such as C. O. Whitman, E. C. Poulton, Oskar Heinroth, Julian Huxley, and others began to exploit the comparative method to trace the evolution of even the most complex social displays of animals. This work inspired the development of ethology primarily through the research and promotional efforts of the Nobel laureates Konrad Lorenz and Niko Tinbergen.

Although when the *Origin* appeared in 1859 Darwin deliberately discussed neither the evolution nor the behavior of human beings, he did, near the very end of the book, include this intriguing passage:

In the distant future I see open fields for far more important researches. Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation. Light will be thrown on the origin of man and his history. (Darwin 1859, p. 488)

Note that this passage considers the psychological aspects of evolution as far more important, in the long run, than the morphological and taxonomic issues to which the *Origin* was largely devoted. Most biologists have ignored the clear evidence, found in Darwin’s early notebooks, that while Darwin may have loved natural history, his ultimate agenda was to explain the origin of perhaps the strangest species of all, ourselves. Thus, in his later writings Darwin

applied the comparative method to show the possible origins of facial expressions in human beings and speculated about many other aspects of abilities typically considered to be uniquely human, such as conceptual thought, language, loyalty, love, and morality (the latter was to Darwin a social instinct). In this way Darwin sought to show that our differences from other species were not major qualitative leaps, but were based on quantitative change that was due to basic evolutionary processes. Furthermore, these differences in degree, not kind, were not due to some external supernatural intervention or a nonmaterial mind. Darwin thus tried to document that human behavior contained instinctive roots that could be traced to our animal ancestors while at the same time arguing that the conceptual, communicative, intellectual, emotional, social, and moral aspects of our behavior also had roots in the behavior and psychology of other species.

These later writings by Darwin greatly influenced the comparative psychology of the nineteenth century. Many early writers, going back to Aristotle, Pliny, and even earlier, had compared the abilities of people with those of other animals and pointed out the surprising abilities of the latter. However, it was Darwin who systematically set out to show that the gap between humans and other animals was smaller than previously thought, and even more important, how the gap could be bridged by natural selection and sufficient time. Darwin's notebooks from the 40 years preceding *The Descent of Man* showed how influenced he was by the similarities of monkeys and apes to human beings.

Darwin and his protégé in comparative psychology, George John Romanes (see, e.g., Romanes 1883, 1892) often relied on casually collected anecdotes and an uncritical anthropomorphism that troubled more experimentally sophisticated scientists. Soon, the study of animal intelligence and abilities was shaped by the writings and work of C. Lloyd Morgan and E. L. Thorndike (Burghardt 1985a,b; Dewsbury

1984). This focus on parsimonious and fairly simple mechanisms to explain diverse abilities had salutary effects in terms of systematizing quantitative research methodology and interpretation when the field was young (see Boakes 1984). Darwin's cousin, Francis Galton, was among the first to develop quantitative and statistical means to study behavior. Nevertheless, by the 1940s, the study of comparative cognition, especially in psychology in the United States, had narrowed greatly; field and naturalistic research was disparaged and many important problems were ignored. The seminal volume of this period is useful in showing the stated breadth and effective narrowing of comparative psychology (Warden et al. 1935). These authors thoroughly criticized early work that was not based on laboratory experimental paradigms and concluded that most of it was virtually worthless, being contaminated by anecdotal, anthropomorphic, and introspectionist errors.

Furthermore, few biology or zoology departments incorporated behavior as an important element in their scientific training and research. European ethologists, with the primary exception of von Uexküll, von Frisch, and Lorenz, ignored the study of the higher levels of cognition and were especially suspicious of studying consciousness and subjective states. Tinbergen (1951) was adamant on this point, almost certainly because of the lingering vitalism concerning instinct and mind found in so many scientists, including his countryman Birrens de Haan. Concerning play behavior, Tinbergen (1963, p. 413) wrote: "Concepts such as play and learning have not yet been purged completely from their subjectivist, anthropomorphic undertones. Both terms have not yet been satisfactorily defined objectively, and this might well prove impossible. . . ."

However, the seeds of the conceptual and methodological tools necessary to reexplore the complex lives of animals were already in place. Wallace Craig (1918) had shown how to separate the motivational and cognitive aspects of instinct

as well as the importance of sequential analysis, primarily in his distinction between appetitive behavior and consummatory acts, a distinction now finally being formally recognized and extended in comparative cognition, as many chapters in this book acknowledge. Von Uexküll (1909/1985) gave us the concepts of Umwelt, Innenwelt, counterworld, sign stimulus, search image, and other useful means for approaching the behavior of other species from their perceptual worlds and not ours. Von Frisch was a brilliant experimenter who, among other accomplishments, showed that fish could hear, honeybees could see colors, and, most amazingly, that bees could communicate information about distant resources, which virtually no other species, except people, could accomplish.

Then, at around the beginning of World War II, other discoveries were being made that would have consequences. One of these was Baerends' demonstration that wasps could assess and hold in memory for a day or more how many caterpillars they needed to provision a nest. This study, presented in a dissertation, was made widely known by Baerends' professor, Niko Tinbergen, in the seminal volume that brought European ethology to English-speaking scientists (Tinbergen 1951). The tidy view that vertebrates, especially mammals, were the most cognitively advanced animals was in effect being challenged by the bees and wasps.

Also around 1940, Donald Griffin, as a student, co-authored a remarkable paper proving that bats used echolocation to navigate in their environment and locate prey. Decades after this work, Griffin finally integrated much ethological work, together with the implications of the abilities uncovered by experimental work on bats and insects, the results of studies on chimpanzee communication, and other diverse information in a remarkable small book, *The Question of Animal Awareness: Evolutionary Continuity of Mental Experience* (Griffin 1976). Griffin advocated a new field, to be called "cognitive ethology" (see Griffin 2001), because he thought that traditional

animal learning and comparative psychology were ignoring the really interesting phenomena presented by animals as a result of their narrowly focused laboratory studies of a few selected domesticated species.

Ethology, on the other hand, was falling under the influence of behaviorists and ignoring the cognitive implications of the flexible and diverse accomplishments their studies of animals were uncovering. For Griffin, cognitive ethology was not only the study of the complex natural behaviors of diverse species, it was also the study of taboo subjects such as consciousness and awareness in other species. A cognitive ethology that ignored consciousness, choice, deliberation, planning, intentions, and other mental processes was, for Griffin, not possible.

The Question of Animal Awareness produced "Amens" in some quarters and outrage in others. Experimental psychologists in particular felt that they had developed methods that could answer the important questions without encouraging unbridled speculation that they, like Tinbergen, felt could never be assessed through the methods of normal science. Nonetheless, in psychology a new cognitivism was displacing behaviorism as the dominant approach and already psychologists studying animal learning were incorporating cognitive approaches while still using standard laboratory methods, although they were applied to more cognitive topics such as concept formation, information retrieval, and memory.

The rich history of behaviorism in fact included such concepts put forth by E. C. Tolman in the 1930s as cognitive maps and latent learning, which were eventually applied to in animal learning (e.g., the radial arm maze) as well as cognitive psychology and ethology. By the 1980s the behavioral concepts and methods of Hull and especially Skinner, which were largely codified in the 1940s, were increasingly applied by psychologists to issues of interest to ethologists, behavioral ecologists, and neuroscientists.

Computer scientists, robotics engineers, and modelers also became interested in the problems

faced by those working with real animals, and neuroscientists began exploring more naturalistic phenomena, such as face recognition, as well. The results of all these broadened perspectives are on display in this volume. Nevertheless, there remain real differences, many of them highlighted in this volume. Some authors are willing, even anxious, to enter the cognitive world and conscious life of their animal subjects. Others explicitly or by omission are clearly uncomfortable with a cognitive study of nonhuman animals that attempts to explore subjective states, intentionality, consciousness, or self-awareness. And, if the science holds, such diversity is both appropriate and defensible.

In addition, philosophers became interested in developing naturalistic approaches to age-old questions about the nature of mind and thereby came to face the challenge that nonhuman animals presented to the traditional anthropocentric philosophy of mind. Ethology, animal learning and communication, and improved understanding of the workings of the brain promised some advances in understanding everything from mind–body relationships to the nature of language, intentionality, ethics, and knowledge itself. Tom Nagel, Daniel Dennett, Steven Stich, John Searle, Ruth Millikan, Jerry Fodor, Dale Jamieson, Fred Dretske, and many other philosophers, despite often remaining wed to traditional philosophical methods of reflection on thought experiments, became fellow travelers with scientists who were studying animal cognition in both the laboratory and the field.

For many years, the primary philosophers to whom experimental psychologists were introduced were the positivists and Ludwig Wittgenstein, while ethologists typically ignored all philosophers (except for Lorenz and von Uexküll, who were very partial to Kant). Evolutionary biologists were largely influenced by Karl Popper.

These trends changed as both cognitive ethology and sociobiology became popular in the mid-1970s. Also, at this time the writings of

philosophers such as Peter Singer and Tom Regan, among others, raised issues concerning our treatment of animals, increasing the stakes and relevance of obtaining accurate information on the emotional and cognitive lives of other species at the individual level and challenging philosophers to pay more attention to evolutionary relationships among species. At the same time, ecological and environmental concerns arose that involved extinction and habitat destruction. Accurate knowledge of the complex behavior and needs of animals became seen as imperative for their very survival in nature or in captivity (Bekoff 1998, 2002).

Today, all the issues and concerns outlined above swirl over, within, and below seemingly straightforward questions about the cognitive lives of animals. The way we answer such questions and apply the findings may tell us much about ourselves as a species as well as having serious consequences for the other inhabitants of this planet. Thus, the way in which the research issues addressed in this volume are eventually resolved (or not resolved) has enormous political implications at many levels. This is probably something most of those working on cognitive aspects of animal behavior are aware of at some level, but typically do not address in their formal writings.

With the above thoughts as a backdrop, we now can turn to the book at hand. The editors bring considerable and diverse research backgrounds and perspectives to this project. Marc Bekoff was trained in neurobiology and behavior, later as an ethologist, and has worked on comparative aspects of behavioral development, social communication, quantitative methods, play, animal ethics, and cognitive ethology for many years, with a particular focus on mammalian carnivores. In 1978 he and Gordon Burghardt edited a volume on behavioral development and evolution (Burghardt and Bekoff 1978). Colin Allen was trained as a philosopher and has written extensively on topics in language, communication, play, and mental evolu-

tion. He has conducted fieldwork on the behavior of birds with Marc Bekoff and has studied learning in domestic pigs. Gordon Burghardt was trained in an interdisciplinary biopsychology program and has focused on the comparative behavioral development of squamate reptiles and the complex interactions between genetic and environmental factors, as well as on play, communication, and the intertwined history of ethology and psychology.

The Cognitive Animal contains fifty-seven compact essays dealing with numerous different topics on a wide range of organisms by researchers in many disciplines. The contributors were asked to consider five questions in their essays. These were (1) What are the central research questions in your study of animal cognition? (2) What theoretical or empirical methods have enabled you to address those questions? (3) What, if anything, do your results reveal about the internal psychological states of animals? (4) What future work is suggested by your investigations? (5) What phylogenetic and methodological limits are there to the study of animal cognition? Some authors stuck to these questions more explicitly than others, but generally the essays address these themes. Also, when taken together, the essays reflect evolutionary, ecological, and comparative approaches to the problems at hand. The importance of careful observation, description, and experiments is emphasized; all are important.

Since our contributors are all well-respected researchers, we allowed them considerable latitude in their presentations, realizing that some readers might prefer some of the chapters to provide more citations to the available literature and to be written in a more formal tone, while other readers might prefer the opposite. As editors, we read each essay carefully and often offered organizational, stylistic, conceptual, and historical suggestions, especially those that would aid readers with different perspectives. However, mindful of our own involvement in the issues covered in this book, we encouraged diverse

voices and not the tight control or limited coverage found in many edited books.

Because this volume did not begin as part of a conference or symposium, we were able to invite a far larger and broader set of authors, both geographically and disciplinarily, than is typically found in a single book, certainly in a volume on this topic. The result is a book about which we are very excited, a volume that could easily be used in advanced undergraduate and graduate courses. It can serve as a useful and fascinating introduction to modern studies and provides examples for those with a general interest in animal cognition. For the professional, it provides an update to work from approaches other than that in which he or she works. Thus there are chapters by cognitive ethologists, behavioral ecologists, experimental psychologists, behaviorists, philosophers, neuroscientists, developmental psychologists, computer scientists and modelers, field biologists, and others.

The potpourri of topics covered in this book resists an easy or concise summary. We have chosen to keep this introduction brief rather than attempting to provide a beginner's guide, for our best advice to beginners is to just dive in. Each chapter is short enough that it may be read quickly and easily reread when contrasting views are encountered in other chapters; in this way understanding can be progressively deepened. The topics include (but are not limited to) definitions of cognition, the role of anecdotes in the study of animal cognition, naturalizing the study of animal cognition, anthropomorphism, attention, perception, learning, memory, ecology, evolution (including discussions of different levels of selection), communication, reproduction, thinking, consciousness, intentionality, rationality, play, aggression, dominance, predation, parent–young interactions and care giving, the role of models, planning, anticipation, kin selection, cooperation, recognition, assessment of self and others, neuroethology, choice, social knowledge, the role of touch, empathy, social symmetries and asymmetries, and conflict resolution.

Even a cursory glance at the essays makes it obvious that in some cases there are different views on the same or similar topics, an aspect of *The Cognitive Animal* with which we are very pleased. Pluralism is a good route to take, given the state of the art. Behaviorism is alive and well, as are rich cognitivism and more middle-of-the-road perspectives, and all of these approaches need to be given serious attention in future research. We also hope that these chapters will aid in the development of more understanding and reduce the polemics among all those who strive to elucidate the minds of animals.

Given the rich and wide variety of these essays, the task of organizing them in a linear sequence necessarily involved compromises. Two main lines of organization suggested themselves: topical and methodological. We opted for a topical organization because we found that researchers working on similar topics from a variety of different methodological backgrounds have many interesting things to say to each other. Ultimately, people (particularly potential students) are interested in the field of animal behavior because of what animals do, not because of the methods that we use to study them. However, we also believe that the importance of thinking about those methods is highlighted by putting contrasting approaches to similar questions alongside each other.

We also chose to organize the essays along broad rather than narrow topical lines. We found that the chapters could be grouped into four categories under the following headings (with brief explanations):

1. The diversity of cognition (taxonomic, methodological, and theoretical)
2. Concepts and categories (ways in which organisms divide up the world)
3. Communication, language, and meaning (a possible window on animal minds, to borrow Griffin's metaphor)
4. Self and other: the evolution of cognitive cooperators (from self-recognition to social cognition)

Narrower categories would have separated contributions that are clearly relevant to one another. But even within the broad categories we ended up with, there are chapters that might reasonably be paired with others in different categories. For instance, many approaches to animal concepts or to social cognition involve language or communication, and many of the chapters on communication touch upon categorization or concept formation. Furthermore, all the chapters provide a theoretical perspective, but those in the first section tend to be more explicit in raising basic and general theoretical questions. The fact that this organizational task was so difficult, and that there are so many overlapping themes even among researchers with very different approaches, speaks to the interdisciplinary nature of cognitive studies of animals.

We hope that these essays stimulate us all to be more interdisciplinary and to rise to challenges to try to answer, and not to dismiss, difficult questions. Difficult does not mean impossible. Learning more about the cognitive capacities of other animals will inform not only the general topic of animal cognition, but also how we interact with and treat other animals. The degree of development of cognitive skills and assessments of intelligence, along with information about the emotional lives of animals, are being increasingly used to make informed decisions about the use of animals in research and education, and for entertainment and food.

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