
Foundations of *Classic Papers*

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PUBLISHED IN ASSOCIATION WITH
The Animal Behavior Society

Animal Behavior *with Commentaries*

EDITORS

Lynne D. Houck and Lee C. Drickamer

THE UNIVERSITY OF CHICAGO PRESS
Chicago & London

PART

1

Historical Origins

The Making of a Science

Bennett G. Galef, Jr.

Humans have been carefully observing the behavior of other animals since before the dawn of recorded history. Extraordinary paintings of horses, mammoths, and reindeer found deep in the caves around Cro-Magnon in France testify to the sophisticated powers of observation and depiction of our Magdalenian forebears who lived and hunted in the valley of the Dordogne some 30,000 years ago. Elegant bas reliefs and paintings of birds, fish, and mammals, common in 5,000-year-old tombs of Egyptian royalty, demonstrate that animal watching did not end with the development of agriculture. Similarly, written descriptions from the fourth century B.C.E. of phenomena as diverse as the role of experience in the development of nightingale song, the copulatory postures of spine-covered hedgehogs, and brood parasitism by Eu-

ropean cuckoos (Aristotle, 1970) show that interest in the behavior of animals survived the birth of Western civilization.

Such fragmentary evidence of early interest in animal behavior tantalizes as it informs, for we know nothing of the methods used in ancient times for observation or experiment and little of the motives of those studying animals in centuries long past. Only in relatively modern times has description of animal behavior been coupled with discussion of how and why the behavior of animals should be observed and analyzed. Such discussions, central to the emergence of a coherent science of animal behavior, became a focus of intellectual activity during the nineteenth century in Great Britain. Consequently, the present review begins in earnest in nineteenth-century England, where early development of a science of animal behavior took place.

Victorian England

During the decades from 1789 (date of publication of Gilbert White's *Natural History of Selborne*) to 1859 (date of publication of Charles Darwin's *Origin of Species*), the study of natural history was pursued with steadily increasing enthusiasm by a broad cross section of British society, "from the aristocrats who competed in turning their parks over to elands, beavers and kangaroos, to the artisans who hoarded their pennies to buy the *Entomologist's Weekly Intelligencer*" (Barber 1980). A Wardian case (terrarium) or Warrington case (aquarium) could be found in the parlor of almost every middle-class Victorian home, and biological supply houses sprang up across England to provide specimens and equipment for local amateur naturalists. By mid-century, run-of-the-mill natural history texts, like J. G. Wood's *Common Objects of the Country* (1858), could sell 100,000 copies in a single week (Barber 1980).

One reason for the exceptional popularity of natural history as a pastime of the Victorians lay in acceptance by gentfolk of observation of nature as a form of "rational amusement," in contrast to "vulgar amusements" like reading novels or attending the theater. To qualify as rational amusement, an activity had to be, at least superficially, either useful or morally uplifting, preferably both. The study of natural history had the good fortune to be perceived as not only scientific, and therefore educational, but also as reverent and inspirational.

In the pre-Darwinian worldview, each animal and plant was seen as perfectly designed for its particular role in nature as the result of intelligent acts by an all-knowing and all-powerful Creator. Consequently, studying the structure and

function of living things was seen as a means of learning about the God who designed them. In the words of Alexander Pope, one of the leading poets of the era, it was possible to look "through Nature up to Nature's God." By studying the beauty and perfection of God's creatures, one could find evidence not only of God's existence but also of His perfection and beauty (Paley 1802). Unfortunately, the necessity of seeing reflections only of God's beauty, perfection, and beneficence in every living thing interfered seriously with both objective description and unbiased analysis of the natural world.

Given the Victorians' professed educational and religious motivations for studying nature, one might expect Victorian books of natural history to be scholarly and serious. They were not. The texts tried to make animals and plants as entertaining and accessible as possible. They were filled with amusing tales about thieving magpies, of elephants who never forgot, of wise old owls and clever foxes. Even sophisticated scientists saw nothing wrong with treating these stories as the raw data of animal behavior. Darwin (1871, p. 449), in a chapter of his *Descent of Man* devoted to "mental powers," relates the following story, one of a number of unlikely tales. "At the Cape of Good Hope an officer had often plagued a certain baboon, and the animal, seeing him approaching one Sunday for parade, poured water into a hole and hastily made some thick mud, which he skillfully dashed over the officer as he passed by. . . . For long afterwards the baboon rejoiced and triumphed whenever he saw his victim."

Writers of books of natural history used their considerable talents to give "seemingly dry disquisitions and ani-

mals of the lowest type, by little touches of pathos and humour, that living and personal interest, to bestow which is generally the function of the poet" (Kingsley, 1855, p. 7). Exercise of poetic license, rather than a striving for accuracy, guided the pen of the Victorian naturalist-writer much as the desire to amuse shapes the scripts of many nature films seen on television today. Success lay in attributing human motives and human-like intelligence to the actions of every bird, bee, and Barbary ape. Scientific journals were as open to anecdote (informal observations of behavior) and to anthropomorphism (attributions of human mental experiences to animals) as were lay publications. The distinguished British journal *Nature* (1883, p. 580) published a letter from a Mr. Oswald Fitch describing a domestic cat that took some of its own dinner of fish bones "from the house to the garden, and, being followed, was seen to have placed them in front of a miserably thin and evidently hungry stranger cat who was devouring them; not satisfied with that, our cat returned, procured a fresh supply, and repeated its charitable offer. . . . This act of benevolence over, our cat . . . ate its own dinner off the remainder of the bones." Such anthropomorphic interpretation of anecdote was the life's blood of the successful Victorian naturalist.

It is against this background of anecdote, anthropomorphism, and inference of mind from behavior that Darwin's (1872) chapter on instinct, reprinted here from the sixth edition of his *Origin of Species*, must be viewed. In general, Darwin's manuscript is surprisingly modern in tone. Darwin's uncommon common sense serves him well in excluding the obviously exaggerated stories that encumbered the work of many of his predecessors and successors.

Darwin focuses on behavioral phenomena (brood parasitism in birds, slave-making in ants, the behavior of sterile castes of social insects, etc.) many of which still concern us today. Further, he is generally unwilling to attribute human-like emotional responses to animals (though he lapses occasionally, for example, in describing *Formica flava* [a species of ant] as "courageous" and *F. sanguinea* [another species of ant] as on occasion "terrified" and at other times "taking heart"). Darwin also joins the more cynical of his contemporaries in questioning the accuracy of the observations reported by his correspondents: He undertakes his own observations of milking of aphids by ants and the behavior of ant "slaves" and their "masters." He conducts his own experiments on cell-making by honey bees.

In the summary of his chapter, Darwin uses evidence of imperfection in instincts (for example, the occasional decision by European cuckoos to lay their "dull and pale-coloured" eggs among the "bright greenish-blue" eggs of the Hedge-warbler or the tendency of south American shiny cowbirds [*Molothrus bonariensis*] to start, but never complete, their own nests and to lay many eggs on bare ground, where they surely perish) to support his view that instincts have a natural origin. For, if perfection of design is the hallmark of the acts of an omnipotent Creator, then imperfection is evidence of a natural, rather than a supernatural origin of instinctive behaviors.

Darwin's main goal in the chapter is to suggest ways in which natural selection might have acted gradually to shape rudimentary forms of instinctive behaviors into the sophisticated instincts that so impressed his contemporaries.

Darwin's methods are, in large part, those of objective description and com-

parison between species. His conclusion is that perfection of instinct is a "consequence of one general law leading to the advancement of all organic beings,—namely, multiply, vary, let the strongest live and the weakest die."

If Darwin's successors had built on the firm foundation laid down by Darwin in his chapter on instinct, the subsequent history of animal behavior might have been relatively straightforward. Unfortunately, in some later work, as for example in the *Descent of Man* (as quoted above), Darwin (1871) lapses into the language of his contemporaries, relating stories of the "deceit," "artful revenge," "loyalty," etc., of a variety of animals. Equally unfortunately, Darwin chose as protégé and intellectual heir in matters behavioral a young biologist, George Romanes, who adopted wholeheartedly a poetic rather than an objective approach to describing and interpreting animal behavior.

During his brief career in science, Romanes published three lengthy volumes on the comparative study of animal mind. The short passage extracted and reproduced here is from *Animal Intelligence*, a volume Romanes (1882, p. vi) described in its preface as a "text-book of the facts of Comparative Psychology." It proved to be a compendium of occasionally informative description or experiment, numerous wildly implausible anecdotes, and consistently anthropomorphic interpretation of both. The contrast with Darwin's striving for accuracy and objectivity in his chapter on instinct is evident.

The description, in the opening paragraphs of the passage, of rats exhibiting "wise caution," "boldness," "courage," "wonderful cunning," "unselfishness," "affection for human beings," "wonderful intelligence," etc., is no idle literary

conceit. As Romanes (1882, p. 1) explained in his introduction to *Animal Intelligence*, "in our objective analysis of other or foreign minds . . . all of our knowledge of their operations is derived, as it were through the medium of ambassadors—these ambassadors being the activity of the organism. . . . Starting with what I know subjectively of my own individual mind, and the activities which in my own organism they prompt, I proceed by analogy to infer from the observable activities of other organisms what are the mental operations that underlie them." Animal behavior was but an ambassador of the real object of interest, animal mind, which could be studied only by introspection and analogy.

As the passages reproduced here make clear, Romanes was no skeptic; he lacked the sense of what was likely or possible that had led a contemporary, Douglas Spalding (1873, p. 291), to note wryly "the many extraordinary and exceptional feats of dogs and other animals, which seem to be constantly falling under the observation of everybody except the few that are interested in these matters." A similar skepticism led Darwin to undertake the experiments on cell-building in honey bees described in his chapter on instinct.

Romanes's use of unlikely anecdote and of introspection, as well as his attribution of human-like mental processes and emotional states to animals, were consistent with the approach of his contemporaries writing popular natural-history texts. But introspection, anecdote, and anthropomorphism all interfered with development of animal behavior as a scientific enterprise. Each had to be purged from discussions of animal behavior before the field could mature as a science. The purge was not long in coming.

The Turn of the Century

It is somewhat ironic that Romanes chose as a successor (as Darwin had chosen Romanes) C. L. Morgan, who was to write that it was necessary "always to look narrowly at every anecdote of animal intelligence and emotion, and to endeavor to distinguish observed fact from observer's inference" (Morgan, 1890, p. vii-ix). Indeed, it was Morgan who was the first major figure in nineteenth-century biology to question systematically the anthropomorphic analyses of his contemporaries.

Surely the most important sentence Morgan ever wrote, possibly the most important single sentence in the history of the study of animal behavior, appeared in various forms scattered through his (1894) *An Introduction to Comparative Psychology*. The most commonly cited version of what Morgan (1894, p. 53) was to call his "canon," is as follows: "In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of one which stands lower in the psychological scale." It is but one of a series of attacks on the poetic Victorian approach to the interpretation of the behavior of animals that took place late in the nineteenth and early in the twentieth century.

If taken literally, Morgan's canon is not very useful without some description of the "psychological scale" of what constitutes relatively simple and relatively complex psychological processes. Such a scale is difficult to provide, though Morgan, like Spencer (1855) before him, tried. The importance of Morgan's canon resulted not so much from its literal interpretation as from its appeal to the law of parsimony in explaining behavior. Simple explanations were to be preferred

to complex ones and anthropomorphic attributions of human-like intellectual and emotional capacities to animals were no longer to be accepted uncritically.

The usefulness of Morgan's canon in analyses of behavior was forcefully documented by cases such as Pfungst's 1907 study of the performance of Clever Hans, a horse widely reported in the popular press to be able to read numbers and words, to spell, and to make arithmetic calculations. Hans consistently answered correctly questions posed by strangers (by tapping or pointing with his hoof) even when his trainer, Herr von Osten, was not present.

A student, Oskar Pfungst, was asked by the director of the Psychological Institute of the University of Berlin to determine whether Hans really could read and do arithmetic. By using the ingenious method of mixing trials on which questioners knew and did not know the answers to the questions they were asking, Pfungst was able to show that Hans could answer questions reliably only when his examiners knew the answers to the questions that they asked.

Pfungst's observations revealed that Hans had learned to respond to small, involuntary movements made by questioners when the correct answer was arrived at, and Pfungst concluded that Hans could neither read nor write nor perform calculations with numbers. Pfungst's analysis had the important result of promoting a more critical attitude toward those who attributed human-like mental powers to animals (Pfungst 1965).

Anthropomorphism was not the only aspect of the popular Victorian approach to the study of animal behavior to come under attack at the turn of the century. The pages from Thorndike's (1898) *Ani-*

mal Intelligence reprinted here bear witness to the growing unpopularity of the use of anecdotal evidence in discussions of animal behavior. Thorndike's great contributions to the development of the general field of animal behavior lay in his explicit insistence on study of behavior in a systematic, quantitative manner and on his development of experimental methods for use in behavioral investigations. Thorndike used relatively large numbers of subjects in his studies, made an effort to standardize testing conditions, measured performance quantitatively and compared systematically the performance of subjects given different training regimens. His work was innovative and important, especially given that it formed the empirical basis for the first doctoral thesis in psychology that reported the results of research with animals.

Thorndike happened to work in the laboratory on problems of animal learning that in subsequent decades became a central part of research carried out in the laboratories of experimental animal psychologists. However, Thorndike's message was the same regardless of the locale in which behavior was observed or the type of behavior under study; the days of informal, unsystematic observation of behavior had come to an end.

Thorndike was not the first to carry out and carefully describe experimental studies with animals. Some twenty-five years earlier, Spalding (1873) had published an elegant series of experiments on the development of behavior in newly hatched chickens and had discovered the phenomenon that was later to be called "imprinting." At about the same time, Fabre, working in France, had initiated his classic experimental work on insects (Fabre 1879-82). However, it was Thorndike who explicitly rejected the prevailing anecdotalism and provided an explicit rationale for a quantitative ap-

proach to the study of behavior. It was Thorndike's work at the turn of the century that shaped the study of behavior for decades to come.

Ten years later, when Margaret Washburn published her highly influential textbook, *The Animal Mind* (1908; it was to go through four editions, the last published in the late 1930s), she rejected absolutely what she called "the method of anecdote" and adopted instead "the method of experiment." In Washburn's words (1908, p. 11) "the ideal method for the study of a higher animal involves patient observation upon a specimen known from birth, watched in its ordinary behavior and environment and occasionally experimented upon with proper control of the conditions without frightening it or otherwise rendering it abnormal."

In spite of the relative sophistication of her views on method, Washburn (1908, p. 11) like Romanes and Morgan before her, felt that the reason for studying the behavior of animals was to find out about their minds, and that "all psychic interpretation must be based on the analogy of human performance. . . . whether we will or no, we must be anthropomorphic in the notions we form of what takes place in the mind of an animal."

Rejection of attempts to study animal mind or animal consciousness using introspective methods is the subject of the fourth and final article reprinted in the present section. J. B. Watson, its author and father of the "behaviorist" approach to the study of psychology, was concerned with developing scientific methods for studying humans. The chapter reprinted here, from Watson's 1924 text, *Behaviorism*, reflects that interest. However, the behaviorist philosophy that Watson first introduced in 1913 obviously also was applicable to the study of animals.

Watson's (1913, p. 158) views were

presented clearly and forcefully in the opening paragraph of his classic article, "Psychology as the behaviorist views it," quoted below. "Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods."

Watson argued that lack of progress in psychology, as compared with other sciences, was due to the dependence of psychologists on subjective data based on private introspections because such introspections could be neither proven nor disproven in the same way as could the empirical claims in other sciences where data were open to public assessment. Watson believed that subjective data based on introspection were without value. He insisted that psychologists should focus instead on the study of behavior. Watson's behaviorism had a profound influence on the future development of ethology as well as of comparative psychology. For decades after Watson, behaviorists, those trained in biology as well as those trained in psychology, maintained that questions about the mind and consciousness of animals were

unanswerable in principle and that a true science of behavior must be concerned only with observable events: the stimuli impinging on organisms and organisms' responses to those stimuli.

Although the view of the world that follows from such an approach is limited in important ways, it was a significant improvement over the introspectionism and anthropomorphism that had dominated the study of behavior during preceding decades. The rejection of anthropomorphism, introspectionism, and anecdotalism that occurred at the turn of the century set the stage for the exponential growth in scientific study of animal behavior that is still in progress today.

While the great advances in knowledge described in the remainder of this volume occurred largely in the decades after the Second World War, the major intellectual battles that made such advances possible had been fought and won in the preceding generation. An objective, scientific study of animal behavior required rejection of the introspective, anecdotal, and anthropomorphic methodologies that characterized the field in the nineteenth century.

The Present

In recent years, there has been a resurgence, under the label of "cognitive ethology" (Griffin 1976, 1992), of interest in using anthropomorphism, introspectionism, and anecdotalism in the study of the behavior of animals. Thinking about how animals might think has generated many interesting experiments and has led to discovery of previously unsuspected abilities in animals. Informal observations of the behavior of animals in uncontrolled settings have similarly generated some new and exciting hypotheses concerning the behavioral capacities of animals. It

has become clear that even hypotheses about behavior that are based on the unsatisfactory methods of the nineteenth century can be useful, if predictions deduced from those hypotheses are stated in testable form and are then tested using systematic, quantitative methodologies of the sort first advocated by Thorndike.

The total rejection of anthropomorphism, anecdotalism, and introspectionism that developed at the turn of the century was a necessary antidote to prevailing excess. However, there is nothing inherently counterproductive either

in trying to imagine how an animal might view the world or in using unsystematic observations as clues to understanding the abilities of other organisms, if (and it is an important "if") it is recognized that such activities are a means of generating hypotheses, not of testing them. Anecdotes, introspection, and projection onto

animals of human-like mental and emotional states impede development of animal behavior as a scientific discipline only if, as happened in the nineteenth century, such activities replace systematic analyses of observable behaviors in testing hypotheses.

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