

Assessing Animal Cognition: Ethological and Philosophical Perspectives^{1,2}

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ABSTRACT: Developments in the scientific and philosophical study of animal cognition and mentality are of great importance to animal scientists who face continued public scrutiny of the treatment of animals in research and agriculture. Because beliefs about animal minds, animal cognition, and animal consciousness underlie many people's views about the ethical treatment of nonhuman animals, it has become increasingly difficult for animal scientists to avoid these issues. Animal scientists may learn from ethologists who study animal cognition and mentality from an evolutionary and comparative perspective and who are at the forefront of the development of naturalistic and laboratory techniques of observation and experimentation that are capable of revealing the cognitive and mental properties of nonhuman animals. Despite growing acceptance of the ethological study of

animal cognition, there are critics who dispute the scientific validity of the field, especially when the topic is animal consciousness. Here, a proper understanding of developments in the philosophy of mind and the philosophy of science can help to place cognitive studies on a firm methodological and philosophical foundation. Ultimately, this is an interdisciplinary task, involving scientists and philosophers. Animal scientists are well-positioned to contribute to the study of animal cognition because they typically have access to a large pool of potential research subjects whose habitats are more controlled than in most field studies while being more natural than most laboratory psychology experiments. Despite some formidable questions remaining for analysis, the prospects for progress in assessing animal cognition are bright.

Key Words: Animal Behavior, Cognitive Development, Animal Welfare Consciousness

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Introduction

Public concern about the ethical treatment of nonhuman animals is of double importance to animal scientists who must justify their use of animals in scientific research and defend the consequences that their recommendations have for treatment of animals in agriculture. Public interest in the ethical issues has been fueled by seminal works by philosophers (especially Singer, 1975; Regan, 1983; Rollin, 1989). Ethical concern for animals is often based on assessments of their mental capacities, especially the capacity to feel pain consciously. Other mental capacities, such as the formation of desires and expectations,

are also sometimes regarded as important determinants of moral status. There is a long history of controversy about the attribution of mental capacities to nonhuman animals, but a growing number of ethologists and comparative psychologists believe that questions about animal mind can be approached scientifically. Scientific and public interest in questions of animal mind have been particularly stimulated by the works of Griffin (1976, 1978, 1981, 1984, 1992), who urged ethologists to pay more attention to the topics of animal mind and animal awareness. Although Griffin's work has often been harshly dismissed by critics (for a review, see Bekoff and Allen, 1996), it has inspired many ethologists to develop new approaches to the assessment of animal cognition. With more and more basic research by behavioral scientists on cognition in animals, it is no longer possible to dismiss with a wave of the hand the commonsense view that animals have mental states similar to those of humans. Whatever side of the moral and scientific issues one comes down on, it is increasingly necessary for agriculturists to be well-informed about the basic research that seems to support an evolutionarily integrated view of animal and human cognition.

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Perspectives from Ethology

An anecdote about pig behavior illustrates several of the problems faced in interpreting animal behavior. As told to me (D. Bushong, personal communication), this story is about a group of pigs that had learned that they could traverse an electrified fence if they ran through it fast enough. The pigs would begin their run toward the fence and start squealing before they reached the fence, continuing until they reached the other side. Common sense suggests the interpretation that these animals had an expectation of the pain that they would experience upon making contact with the fence. But such commonsense interpretations have often been rejected by scientists on a number of grounds, including worries about the anecdotal nature of the evidence, the lack of experimental control for observations made under field conditions, and skepticism about the possibility of knowing what it is like for a pig to experience an electric shock. The challenge facing scientists is how to turn such anecdotes into data that can support conclusions about animal minds. A subsidiary challenge to animal scientists is to take an improved understanding of the cognitive and mental characteristics of domesticated species and design facilities that are most appropriate for the animals and for their handlers. (See Grandin, 1995, for uniquely personal insight into animal cognition and its implications for the design of animal handling facilities.)

To understand the challenges facing scientists who wish to investigate questions of animal mind, it is useful to know a little about the history of ethology and comparative psychology. Charles Darwin wrote a great deal about the evolution of mind and behavior. He was strongly motivated to establish a high degree of continuity in physical and mental characteristics between humans and other animals, and he sometimes accepted claims about parallels between humans and other animals rather too uncritically on the basis of anecdotal evidence. Darwin's "anecdotal cognitivism" (Jamieson and Bekoff, 1995; Allen and Bekoff, 1997) was pursued by contemporary comparative psychologists such as George Romanes, but it came under considerable scrutiny in the early part of the 20th century when many psychologists became convinced that scientific study of behavior was possible only if one limited oneself to discovering laws relating observable stimuli to observable responses (Boakes, 1984). Behavioristic psychology became increasingly preoccupied with the discovery of general principles of learning and behavior that were not species-specific, and consequently it became more detached from the concerns of evolutionary biologists who are interested in variation among species.

Ethology, as a recognizable subdiscipline with evolutionary biology, started with the work of Konrad Lorenz and Niko Tinbergen little more than half a century ago. Lorenz and Tinbergen were concerned to

show how Darwin's theory of evolution could be applied to behavioral phenotypes as systematically and rigorously as it had been applied to the anatomy and morphology of plants and animals. From the beginning, the pioneers of ethology were concerned to understand behavior in natural settings, which, they supposed, more accurately reflected the conditions under which animals had evolved than the conditions imposed in psychological laboratories.

Systematic investigation of the evolution and function of behavior is difficult because of the plasticity and variability of behavioral traits and the lack of an historical trace for behavior in the fossil record. The battle for scientific respectability for ethology required the development of a strongly comparative method that allowed inferences about the function and evolution of behavior to be drawn from careful comparisons of the relationship of behavior to environment within and between species (Tinbergen, 1963; Lorenz, 1981). As well as studying evolution and function, ethologists are concerned to understand the proximal mechanisms underlying behavior. The early relationship between ethology and psychology can be seen in the original name of the journal *Ethology*, which was *Zeitschrift für Tierpsychologie*. Reflecting the psychology of the day, the concepts introduced by Lorenz and Tinbergen to explain the behavior of animals provided only relatively simple models of the internal workings of organisms. For the past 20 yr, Griffin (1976, 1978, 1981, 1984, 1992) has argued that ethologists should broaden their sights to include questions about the cognitive and mental capacities of animals, for which he coined the term "cognitive ethology." Although "cognition" cannot be defined uncontroversially, it is useful to think of cognitive processes as involving the synthesis of information from diverse sensory and memory sources to produce appropriate responses. Many cognitive scientists regard computer programs as the best model for understanding how represented information can be manipulated in a sophisticated manner. However, Griffin has also urged scientists to consider the issue of consciousness, which is not so easily understood in terms of computational models (Searle, 1992; Chalmers, 1996).

In common with classical ethology, many of Griffin's battles on behalf of cognitive ethology have been about the possibility of using naturalistic methods to investigate questions about mind and cognition in a systematic and scientifically rigorous fashion. (A terminological aside: "mind" and "cognition" are not, I think, generally equivalent terms because the former has greater implications about consciousness (Allen, 1997), but I'll tend to use them equivalently here because I do not wish to exclude the study of consciousness from consideration.) Many scientists, including those with training in behavioristic methods, are now comfortable with the attribution of internal representations to animals, but there is much residual skepticism about the notion of consciousness

and other terms, such as “belief,” “desire,” or “concept,” that seem to suggest consciousness (Blumberg and Wasserman, 1995). Because of his insistence on placing consciousness at the top of his agenda, Griffin has been accused of anthropomorphism (Kennedy, 1992; Blumberg and Wasserman, 1995) and just plain muddled thinking (Heyes, 1987; see Bekoff and Allen, 1996, and Allen and Bekoff, 1997 for reviews). The mere charge of “anthropomorphism” is question-begging, for the attribution of human-like mental qualities to nonhumans is incorrect only if they genuinely lack those qualities. The question of whether animals lack the mental properties is precisely what is at issue, so it can't simply be assumed that it is unreasonably anthropomorphic to consider the question of animal minds. Sophisticated critics typically dispute the possibility of a firm methodological and philosophical foundation for the attribution of higher mental states to animals using observational methods (Heyes and Dickinson, 1990, 1995; Allen and Bekoff, 1995).

Progress in the philosophy of mind and the philosophy of science can help to answer the criticisms leveled at those who attempt to investigate animal minds. Some readers will be skeptical about the suggestion that there is progress in philosophy. Philosophy moves so glacially that it commonly gives the impression to those outside the field that there is no progress at all. And philosophers are not good about disseminating their results beyond other philosophers, so news of progress travels at a similarly glacial pace. But despite appearances there is progress; in particular, better understanding by philosophers of science of the relationship of theory to evidence and better understanding by philosophers of mind of the material bases of mental capacities are two factors contributing to more sophisticated attitudes toward animal cognition.

Perspectives from Philosophy of Science

Scientific attitudes are, in large measure, a product of education. Given the (lack of) speed at which philosophical results travel, it is hardly surprising that many prevailing attitudes about the methods of science themselves are based on theories of science that philosophers would consider to be outmoded. This has particular application to the study of animal mind because of the lingering effects of the early 20th century movement known as “logical positivism.” Positivism arose a little under a century ago in the midst of great advances in the study of logic and its application to scientific method. Philosophers such as Carnap (1928) initially thought that scientific statements should consist only of descriptions of direct observations or logical constructions from observation statements. In physics, this was taken to entail that concepts (such as that of an electron) referring to

entities that cannot be directly observed should be interpreted as abbreviations for complex sets of descriptions, of the readings one could make on scientific instruments, for example. In psychology, it was taken to mean that concepts such as mind, belief, consciousness, and so on should either be operationally defined in terms of behavioral observations, or, if that was not possible, eliminated altogether from the science. Thus, for instance, in describing the pigs earlier, it would be required to operationalize the notions of pain and expectation in terms of behavioral measurements. This view had the effect that statements about consciousness and other unobservable aspects of mind were widely taken to be unscientific; ethical issues were similarly dismissed. (See Rollin, 1989, for a comprehensive account of the effects of positivism on scientists' views about animal mind and suffering.)

Among philosophers, the project of defining theoretical terms in terms of observations was, by the middle of the 20th century, abandoned by even its most prominent advocates, including Carnap. A chief problem facing positivism is that it seems impossible to give an inclusive operational or observational definition of most important scientific concepts; there is an indefinite number of ways to detect or measure the presence of an electron, for instance, such as observing trails in a cloud chamber or light emitted by a fluorescent screen. Another problem relates to the logic of experiments, observations, and theories. The philosopher Quine (1953) revived an argument by the physicist Duhem (1906), who pointed out that no simple relationship between theoretical claims and observations exists. According to the Quine-Duhem thesis, the interpretation of any experimental result depends on the simultaneous acceptance of multiple theories, both scientific and mathematical, and no one of these can be evaluated in isolation. Thus, any particular observation cannot straightforwardly be tied to a particular theoretical concept, for the interpretation of each observation involves many theoretical concepts.

Thus, a piece of progress in philosophy of science is the recognition that theories are not strictly logical constructions from pure observations, but that there is a complex interplay between theory and observation, each playing important roles in the scientific process. The exact details of this interplay are still being worked out, and it would be unwise to expect anything but glacial progress in philosophical understanding. But a widely held view that is of particular interest for my topic in this paper is that theories are supported by a form of “inference to the best explanation.” In particular, then, a cognitive explanation of some behavior may be preferred to a noncognitive explanation if the former is, in a sense that needs to be specified, better than the latter.

What makes one theory better than any other is dependent on many factors, including breadth of scope

and consistency with the rest of science. This is important for the assessment of cognitive approaches to animal behavior because the strategy of inference to the best explanation allows one to make use of unobservable entities in one's theories if doing so increases the explanatory power of those theories. If it can be shown that cognitive approaches have the power to explain more than noncognitive approaches, then there are grounds for preferring the cognitive approach. Darwin's anecdotal cognitivism and Griffin's subsequent contributions have seemed to many to fail to provide a systematic approach that is applicable in field conditions. Other researchers have, however, stepped forward to meet the challenge. For example, Ristau (1991) conducted elegant field experiments showing that piping plovers monitor and remember the behavior of potential predators coming near their nests, in order to choose an appropriate response to the threat that this poses for eggs or chicks. Ristau claims that the ideas for the experiments she conducted would never have arisen without taking a cognitive perspective.

Some of the most innovative studies by cognitive ethologists involve the application of methods that make use of traditional behavioristic notions such as habituation, but in novel ways. For example, vervet monkeys were observed by Cheney and Seyfarth (1990) in response to repeated playings of the vocalizations of a specific individual from a concealed speaker when that individual was not present. When the vervets became habituated (i.e., they ceased to respond to the taped vocalization), a different vocalization was played. If a response was seen, then the habituation had not transferred, but if the call was ignored then it had transferred. The results showed that transfer of habituation could occur across acoustically dissimilar calls when those calls were used in similar (social) contexts. Because the calls are acoustically dissimilar, the best explanation for these results is that the vervets categorize calls according to what they mean, not what they sound like. The idea for these experiments arose as a direct result of adopting a cognitive perspective that viewed the monkeys as understanding their vocalizations rather than merely responding in an automatic fashion. Similar techniques involving habituation have been developed from methods used to study cognition in prelinguistic human infants. For example, researchers have used an habituation/dishabituation test to show that monkeys can keep track of simple addition problems and have concepts of physical objects that do not permit the passage of one physical object through another (Hauser and Carey, 1997).

What makes these approaches to cognition more tenable than earlier anecdotal approaches is that hypotheses about the mental representational capacities of the animals are used to make predictions about the kinds of responses the animals will make in different situations. These predictions, and the cor-

responding experimental designs, are guided by close attention to the biological functions of the capacities involved. Animals are tested on problems that involve the kinds of stimuli that their capacities evolved to handle rather than on arbitrary pairings of biologically meaningless stimuli, such as lights and tones, that are common to many laboratory studies of animal behavior.

Perspectives from Philosophy of Mind

Many of the worries that scientists in general and behaviorists in particular have about mental states can be traced to the association of such ideas with belief in the existence of mysterious, ghostly substances, or souls. This immaterial conception of mind is most commonly associated with the philosophy of Descartes, who placed mind outside of the usual causal mechanisms involving physical things. Many scientists who study animal behavior continue to have an aversion to talking about mental states for just this reason, and they sometimes wrongly assume that the willingness of philosophers to talk about beliefs, desires, or consciousness represents a return to ghostly Cartesianism. If philosophers were indeed committed to Cartesian souls, then scientists would be right to recoil. But here again is another case where developments in philosophy have been slow to spread beyond the borders of the academic discipline. For many years now philosophers have sought a theory of mind that firmly locates mental phenomena as part of the natural world. How is it, philosophers ask, that ordinary physical matter can organize itself to produce complex mental abilities? Here, contemporary philosophy of mind makes a distinction that is not very intuitive to common sense, between the *representational* or *meaningful* properties of mental states on the one hand, and *consciousness* on the other.

Of the two, we are much closer to understanding representation and meaning than to understanding consciousness, although there remain unsolved puzzles for both. Representation seems puzzling to philosophers because it has features that are hard to account for in directly causal terms. For example, the anticipation by pigs of future pain would require the ability to represent future events: events that have not yet occurred, and may never occur (if the electricity has been turned off, for example). Clearly these future events cannot be causes of such representations, so how is it that a neural state may represent something that does not yet exist?

There are numerous philosophical theories of representation on offer, but I will consider just one of them, due to Millikan (1984), to illustrate how it may be possible to make progress on this issue. (For a survey of other approaches, see Allen, 1995.) The theory is strongly evolutionary because it is based on

the idea that representation is a kind of biological function based on the history of natural selection within a species. Many organisms have evolved nervous systems whose function it is to coordinate behavior that is appropriate to circumstances. The normal operation of these nervous systems typically depends on a correspondence between events outside the organism and neural states. Such a correspondence may be between neural states and external events that are displaced in time, and in such cases we may say that it is the function of the neural state to represent a future (or past) event. Pigs can be said to have an expectation of pain because it is a function of their neural state (which also caused the squealing) to correspond to, and hence represent, subsequent states of pain. (For the moment we are just taking the pigs' experience of pain for granted.) The fact that, sometimes, the represented event does not occur is no more problematic on this view than the fact that biological systems frequently fail to perform their functions: most sperm, for instance, fail to penetrate an egg (Millikan, 1984).

This biological approach, whose details are still being worked out (Millikan, 1993), has the potential to shed light on a number of processes in animal behavior. For example, the social play behavior of canids involves the use of signals that serve to establish and maintain a play mood, allowing other behaviors that might otherwise be interpreted as aggressive or sexual to be incorporated into the play sequence (Bekoff and Allen, 1992). By adopting a cognitive approach that views these signals as meaningful, Bekoff (1995) was able to formulate and test hypotheses about their nonrandom placement during a play sequence. In particular, it was found that play bows are more likely to occur just before or just after a bite than at other times during the play sequence. This result can be best explained if play bows provide a message about the significance of other actions that the animal performs: that the bite is playful, not aggressive.

The ability to categorize some bites as playful and others as aggressive illustrates a basic feature of cognition. Correct categorization of various features in the environment is important if an organism is to respond adaptively to those features. Because different species have evolved in different environmental niches we must expect a variety of categorization abilities among different species, each geared to the types of problems normally faced by its members. A more advanced level of cognition involves not just categorization, but the ability of an organism to monitor and correct its own categorization errors, such as when a human being recognizes a visual illusion despite the fact that the illusion persists. In such cases there is the recognition that although things appear (consciously) to be one way, they are in fact another.

This brings us to the issue of animal consciousness, which is more difficult to deal with, partly because the

term "consciousness" does not have a unique meaning (Wilkes 1984; Nelkin, 1993). In some senses of the term, it is uncontroversial that animals are conscious, such as the sense of being awake, and the sense of being aware and responsive to features of the environment. Trouble seems to arise when we humans try to imagine what it might be like to be a member of a different species (Nagel, 1974). Just as one may, however, know that a particular experience of another human being (e.g., of a different gender) is conscious, without knowing exactly what the experience is like for that person, so too one should distinguish the question of what it is like to be a pig from whether the pig's experiences are conscious. The ability to detect and respond to certain kinds of perceptual error may provide relevant evidence, because it establishes that the organism makes an internal distinction between the way things *appear* to it and the way things are (Allen and Bekoff, 1997). Conscious experiences may provide the best explanation of the animal's capacity to recognize that the way things appear to it may not correspond to the external reality. Whether this approach to conscious experience could be applied to animal pain remains to be investigated. The anecdote about pigs, however, provides an interesting consideration, for it shows that pigs may be able to weigh the appearance of harm that accompanies pain against the minimal actual harm sustained by contacting the electric fence, and decide that the experienced harm is outweighed by the benefits of crossing the fence.

Implications

Domesticated animals are relatively easy to observe and maintain in natural or seminatural conditions and they make good research subjects for cognitive studies. The theoretical and practical consequences of cognitive studies of domesticated species are virtually unlimited. The design and execution of such studies can be difficult and time-consuming, and convincing peer review committees of funding agencies will continue to be a hard sell for the foreseeable future. Nonetheless, research into the cognitive abilities of domesticated animals is essential if specific welfare needs are to be met; it is not appropriate to extrapolate conclusions about the ethical treatment of one species from research conducted on others. Perhaps it is too much to hope that there will one day be a journal of applied cognitive ethology, but the prospects are bright for animal scientists to contribute to further progress in understanding animal cognition.

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