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Varieties of Purposive Behavior

In anthropomorphism, animals are credited with having intentions, plans or human-like purposes, that is, cognitions. Concerns about anthropomorphism can focus on whether any one (or all) of three parts of this attribution is accurate: that animals have purposes at all, that animals have cognitions, and that animals have human-like cognitions. In order to know whether such concerns are appropriate, one needs some sort of theory concerning what purposes, cognitions, and human cognitions are, some theory about what exactly it is that one is attributing to the animal. In this essay, I supply such a theory, which differentiates two broad kinds of purposiveness in behavior: biological purposiveness, and "intentional" purposiveness--the kind that involves cognizing purposes, having plans. I argue that there can be no study of behavior that fails to rely, at least implicitly, upon speculation concerning the biological purposiveness of that behavior. Thus, the attribution of purposiveness per se to animals is not something to be avoided, indeed, it is best if the necessary attibutions are made as explicit as possible.

Intentional purposiveness is more problematic. Intentional purposiveness is a form of biological purposiveness. It involves a particular kind of mechanism for the implementation of biological purposes. Intentional purposiveness undoubtedly comes in numerous forms, some much less complex than those exemplified by human intentions. To attribute cognition to nonhuman animals need not be, and surely in most cases should not be, to attribute the human kind of cognition to them. There are intermediate possibilities.

I begin by describing biological purposes and showing how behavior is recognized with reference to biological purposes. (A much fuller treatment of this theme may be found in (Millikan 1993) chapter 7.) I then describe intentional purposes and cognitions, suggest how human cognitions may differ from those of nonhumans, and describe some forms which nonhuman cognition may take. (Fuller treatments may be found in (Millikan 1984) and in (Millikan 1993) chapters 3-9.)

By a "biological purpose" or a "biological function" (I intend these as synonyms) I mean the kind of purpose that the heart's beating has. The purpose of the heart's beating is to circulate the blood. Similarly, the purpose of your skin's flushing in the heat is to dispel heat from your blood, the purpose of the frog's flicking out its tongue when the right kind of shadow crosses its retina is to effect the ingestion of flies. In general, the biological purpose of a behavior is whatever salutary effects this behavior has had often enough, during the evolutionary history of the species, to help account for the current presence in the species of the mechanisms that produce the behavior. Crudely, biological function is historic survival value.

My first task will be to clarify why it is that one cannot study behavior without making at least implicit reference to the behavior's biological purpose. Indeed, one cannot even pick out behaviors as the objects of one's study antiseptically, in a way that is theory free, free from all speculation about biological function. What observations count as among the data for any particular science is never a matter that can be settled apart from theory--a point that is universally recognized by reflective contemporary scientists and philosophers of science. For example, classical chemistry studied chemical compounds and not solutions or mixtures, but what is a compound and what is a solution or mixture is a matter that is determined by chemical theory, not prior to theory. How is this general principle manifested in the sciences of behavior? Indulge me for a moment as I display some species specific philosopher's behavior. I propose to point out something so close to our noses that we tend not to notice it. Then, when you have noticed it, and noticed how familiar and obvious it is once pointed out, hence how trivial it is, I will insist that in fact it is deep and profound.

The invisible yet obvious fact to which I would direct your attention is that there is a literal infinity of different possible descriptions that might be given of any animal's behavior at any given time, only a tiny few of which descriptions have any relevance for behavioral science. These are the descriptions that connect in a pertinent way with function. Consider, for example, the various motions that an animal makes. A good portion of the behaviors of animals are motions of one kind or another. But motions can only be described relationally. Relative to what do we describe the animal's motions? Consider Amos, the mouse, there on my kitchen floor. He runs in the opposite direction from the waiting cat. In the same motion, he runs toward the waiting broom. He also runs between a black square on the linoleum and a tomato stain, towards the kitchen clock and towards London, away from magnetic North, thirteen times as fast as the clock's second hand swings, five seconds after the last perceptible motion on my part, .05 seconds after the last agitated flick of the cat's tail. Clearly this list of descriptions of Amos's running could be extended indefinitely. And wait; is his behavior even a running? Perhaps Amos's motion should be described merely as a rhythmic beating of the paws, which happens to carry Amos across the floor, just as it happens to carry him toward London.

Nor will it help to relativize Amos's motions to his own body. Notice Amos as he blinks. Are his eyelids momentarily covering his eyes? Or are his eyelashes being disentangled momentarily from his eyebrows? Or do the eyelashes point momentarily to the navel, or is it to the toes? Perhaps all that occurs is a rotation of the eyelids. Do they rotate at an angular velocity of 1000 degrees/sec, or is the rate equal to three revolutions per mouse heartbeat?

Nor are motions in any way peculiar with regard to the infinity of their possible descriptions. Amos can make squeeks, chattering sounds, sneezes, coughs, choking sounds, or he can be silent--silent except that, if you listen closely, he makes breathing sounds, and little thumping sounds with his feet (danger signals, or just foot patter?)-- and also with his heart. Which of these sounds, and which silences, are subject matter for behavioral science and which are not? How should the sounds be described? By pitch, or inflection, duration, periodicity, harmonic structure, rhythmic structure, amplitude, pattern of repetitions? Consider the sounds that a human makes. Some of these, such as screams and laughs, can be described relatively crudely. Others, the speech sounds, need to be described in great detail, and in accordance with principles of such subtlety that these are not yet fully understood. Still other sounds, such as sounds made while choking or urinating, sounds made by the heart and, normally, those made in breathing, do not need to be described at all. Sometimes silences need to be described and sometimes they do not.

Given the infinity of possible descriptions of behavior, what determines the forms of description relevant to behavioral science? Which behaviors, which describable outputs, are true "Behaviors", using a capital 'B'--outputs that are proper subject matter for animal behavior studies?

Does one look, perhaps, for repeated behavioral units, for patterns that recur? That mice run away from cats, for example, is a recurrent phenomenon, that they run toward waiting brooms is not. But that cannot be the answer. For the heart says "pit-a-pat" with wonderful regularity, every mouse eyeblink is a momentary disentanglement of its eyelashes from its eyebrows, every mouse foot touching the floor makes a miniscule thump, and choking is a distinctive and reliably reproducible sound, under the right stimulus conditions, yet none of these are Behaviors with a capital 'B'. Equally, it is a mistake to think that what we are after is whatever behavior falls under laws. All of the above behaviors fall under laws, indeed, unusually reliable laws. Consider the knee jerk reflex, which falls under a wonderfully reliable law. The physiologist looking for clues concerning the engineering of the body is interested in knee jerks. But if knee jerks are ever of interest to students of behavior, this is not because they are Behaviors, but only because they can be used to help diagnose the condition or give clues about the inner structure of mechanisms that <u>are</u> responsible for true Behaviors.

No. What makes it that this output of an animal but not that is a proper piece of Behavior, or that an output <u>described</u> this way rather than that is a proper piece of Behavior, is always some kind of intimate relevance to biological function. The knee jerk is not a Behavior because it has (so far as we know) no function. It doesn't effect anything that has aided survival. For the same reason, it is unlikely that choking sounds are Behaviors, nor sneezing sounds nor coughing sounds. On the other hand, sneezing and coughing themselves probably are Behaviors; probably having mechanisms that produce sneezes and coughs has survival value. Blinking is properly described as covering the eyes with the eyelids because that is what effects, say, keeping out the sand, while disentangling the eyelashes from the eyebrows and pointing with the eyelashes toward the toes have no functional effects. Amos's behavior is not just a rythmical moving of his paws but a full fledged running across the floor because it is historical runnings and not just historical rythmic paw motions on the part of Amos's ancestors that, characteristically, contributed to survival. On similar grounds, whatever may or may not be "in his mind", Amos's Behavior is surely a running away from the cat, and just as surely is not a running toward the broom or toward London. That the perceptual-motor systems Amos inherited from his ancestors and that are responsible for his current running are systems that, operating so, sometimes effected removal of those ancestors from the vicinity of predators, certainly helped account for their proliferation; that these mechanisms effected approaches to brooms or, say, to large cities, certainly did not.

What counts as a true Behavior is what is assumed to have, under that description, a biological purpose. Often this point of theory drops into the background because it is so evident which behaviors must be functional, which not. It is evident, for example, that Amos is to be described as running, but surely not as running towards London--so evident, indeed, that it is hard to discern how any deep point of theory could possibly be lurking here. Other times, however, it is not a bit obvious what an animal is doing that constitutes its true Behavior. Colin Beer, for example, tells an involved story about his struggles to discover where the true behaviors lie within the vocalizations and displays of laughing gulls (Beer 1975, 1976). And it is well to be aware that every description, every classification, of a behavior makes an implicit reference to known or unknown biological purpose. If one is not aware that theory is inevitably involved even at this level, one will surely be more likely to import implicit bad theory, for example, to import unexamined anthropomorphism, into one's descriptions of behavior. The unreflective human, asked to describe the behavior of another species, naturally relies on projection: what would I be doing if I were acting like that?

Attributing biological purposes to behaviors is not, of course, the same thing as attributing thoughts or cognitions. It may be a function of the eyeblink to effect keeping out the sand, but neither the eye nor the animal as a whole must cognize this goal in order to blink. Similarly, suppose that you condition my operant eyeblink response by reinforcing it with your smile. My blinking will then have acquired a new biological goal, as it produces your smiles in accordance with the biological design of my learning systems. Compare: the pigment rearranging mechanisms in the skin of an old world chameleon can be said to flip from having the biological purpose of making the chameleon appear brown to having the biological purpose of making it appear green as the chameleon moves from a brown to a green surface. Similarly, the biological purpose of a conditioned response can be said to depend upon the environmental circumstances that produced it. (For a fuller treatment of this theme, see (Millikan 1984) chapter 2 and (Millikan 1993) chapter 9.) But though my blinking may have making you smile as its biological purpose, I will not cognize this purpose, I will not blink because I think, either consciously or unconsciously, of this purpose. S-R learning does not, in itself, produce cognition. Whether learned or unlearned, differential responses are not thoughts. What then are cognized purposes, intentional purposes? How do they differ from learned or unlearned biological purposes?

The word "intentional" (with a 't') is used by philosophers to refer to items that are about other things, as, for example, the sentence "Paris is pretty" and a map of Paris are both about Paris. The belief that Paris is pretty, the desire to visit Paris and the intention to visit Paris are of course also about Paris. All of these items exhibit "intentionality." External items that exhibit intentionality, such as sentences, graphs and charts, maps, road signs, sheet music, and representational paintings, are called "representations". Similarly, a dominant theory to which I subscribe proposes that inner intentional items such as beliefs, hopes, desires and intentions are similarly representations. More generally, all cognitions are inner representations, that is, inner models, in the most abstract mathematical sense, of what they are about (Millikan 1984, 1993 chapters 3-5). The difference between merely biological purposes and intentional purposes is that in the latter case the animal's biological purposes are implemented via the manufacture and use of inner representations--representations of the environment and/or representations of the animal's goals. Human beliefs, desires, and intentions are then differentiated by being embodied, at least in part, in an especially sophisticated system of inner representation, on which I will comment soon. Without doubt, however, humans also continue to rely at other levels of cognition upon more primitive forms of representation.

To give you some idea of how abstract the models that are representations can be, English sentences are such models. Significant transformations of English sentences (substitution transformations, for the most part) correspond to transformations in what the sentences are about; the domain of true sentences maps onto, or bears an abstract isomorhism to, the domain that is the real world. Or for those acquainted with this field, neural network modeling is in large part an investigation of certain very abstract forms that mental representation may possibly take. The animal that cognizes is capable of constructing a variety of alternative inner models, presumably states of its nervous system, which accord, by certain abstract rules of correspondence, with what the animal thinks about. These abstract models, abstract mathematical "maps", may function as maps of the environment, modeling facts about the animal's world, or as blueprints showing desirable outcomes of actions, or plans adopted for action.

Let me try to make this more concrete by calling on a close anology. Consider for a moment the dance of the honey bee. Transformations of the dance (e.g., a rotation of the long axis of the dance by so many degrees) correspond to transformations in what is represented (changes in the represented direction of nectar from the hive). The dance is an abstract mathematical map, a representation, of the location of nectar. The biological purpose, which is to get the worker bees to supplies of nectar that have been spotted by their coworkers, is effected by the cooperation of two kinds of systems. The first produces maps of where the nectar is. These serve as blueprints of concrete biological goals to be achieved, the goals, namely, of getting to this place, or that place, where the nectar is. The second kind of system "reads" these blueprints, that is, reacts to them appropriately, in a manner such as to achieve the projected biological goals. In this case some bees dance while others watch: the representations are not inside the bees but outside. The dances are representations, but not, as such, cognitive representations or cognitions. Suppose, however, that the mechanisms responsible for manufacturing a model of the environment, the model itself, and the mechanisms responsible for interpreting it, were all within the same organism. Then you would have primitive <u>cognitions</u>--thoughts (though not necessarily conscious ones) of the layout of the environment, thoughts of goals to be achieved.

To attribute <u>intentional</u> purposes to an animal is to attribute to it some kind of inner representational system, some way of mapping the world and its goals which serves as its means of achieving those goals. The truly interesting part, however, is to reflect on the variety of <u>ways</u> that mapping principles might be employed by biological systems. For example, there are a number of very fundamental respects in which human beliefs and desires must differ from representations like bee dances (besides, of course, that bee dances are not inside the organism, hence not cognitions). I will mention three such differences. (Various other crucial differences are enumerated in (Millikan 1993) chapter 4).

First, bee dances are undifferentiated between the indicative or fact stating mood and the imperative or direction giving mood. The dance tells the worker bees where the nectar is (facts); equally, it tells them where to go (directions). The step from this kind of primitive representation to human beliefs and intentions is an enormous one, for it involves the separation of indicative from imperative functions of the representational system. Representations that are undifferentiated between indicative and imperative connect states of affairs directly to actions, to specific things to be done in the face of those states of affairs. Human beliefs are not tied directly to actions. Unless combined with appropriate desires, human beliefs produce no action. And human desires are equally impotent unless combined with beliefs about how to fulfill the desires. But there is no reason to suppose that the capacity to retain purely factual knowledge, knowledge disconnected from any specific projected uses, or to harbor explicit desires disconnected from any specific ideas about how to fulfill them, is a feature of every animal that cognizes. Many may harbor only undifferentiated inner representations.

Second, since indicative and imperative functions are separated in the inner representational systems of humans, they need to be reintegrated in order to produce actions. Thus humans engage in practical inference, combining beliefs and desires in novel ways to yield first intentions, and then action. Humans also combine beliefs with beliefs to yield new beliefs. But it may be that other species do not have such inference capacities, or have them to a more limited degree.

Third, the representational system to which the bee dance belongs does not contain negation. Indeed, it does not even contain contrary representations. If two bees dance different dances at the same time, these dances do not conflict, for it may well be that there is indeed nectar in two different locations at once. (On the other hand, the bees can't go two places at once.) But in a representational system without negation no contradictions can occur. If the inner representations of a cognizing animal were to lack negation, hence the potential for contradiction, this would be highly significant. If we follow philosophical tradition, the law of contradiction plays an absolutely crucial role during acquisition and development of all concepts not definitionally tied to a given significance for action. Animals lacking negation in their inner representational systems would be unable to learn new concepts except in so far as these were directly tied to action. All of their concepts would have to be either purely practical, or static, hereditary, built in. Moreover, I have argued that negation is dependent upon subject-predicate, that is, propositional, structure and vice versa. Representations that are simpler do not express propositional content (Millikan 1984). Even such soophistocated representations as maps, charts and sheet music do not contain subjects and predicates. Animals that thought exclusively in representations without subject-predicate structure would not think propositions.

To attempt to express the contents of the cognitions of animals that were undifferentiated between indicative and imperative mood, or cognitions without subject-predicate structure, or that were not subject to negation, or that did not participate in processes of inference or information transformation, by translating these into or correlating them with English sentences, would not be at all accurate. Taking an extreme example, consider the "fly detector" in a frog's optic nerve. It might be considered to produce an extremely elementary sort of inner representation. The firing of the detector at a certain time and place maps the presence of a fly at a certain time and place--the same time and place. Firing at another time and place represents a fly at a different time and place. Or should we say instead that the firing is really an imperative representation that tells the frog to snap at a particular time and place? Does it say "There's a fly here now" or does it say "Quick, snap here now"? Yet the firing of the detector really tells the frog (or its brain) neither of these things. To say "There's a fly here now" it would have to contrast with a possible representation that said "There's not a fly here now", and with possible representations that said, say, "There's a beebee here now" or "There's a cat here now" or "There was a fish on Tuesday at four".

What is really needed in order to understand nonpropositional animal cognition is not a translation into English, but explicit description of the kinds of representational systems such animals in fact use, and their ways of using them. The ultimate goal must be to construct and test models of the cognitive systems of each of the various animal species, much as human psychologists are beginning to construct and test models of human information processing. The ultimate confirmation of such models will lie in the minute physiologies of the various species. At the moment, however, for the most part we can only speculate about what various kinds of representational systems are in principle possible, and which of these might in fact be used by biological systems. But we will surely go astray if we fail to keep in mind that between human propositional thought, and no thought, there are many intermediate possibilities.

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