CHAPTER 4

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Comparative Psychology Meets Evolutionary Biology

Morgan's Canon and Cladistic Parsimony

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For many scientists, "anthropomorphism" is the name of a factual mistake and an intellectual failing. Anthropomorphism is often defined as the error of attributing human mental characteristics to nonhuman organisms; people are said to fall into this error because they are sentimental and uncritical. It is a revealing fact about current scientific culture that the opposite mistake—of mistakenly refusing to attribute human mental characteristics to nonhuman organisms—does not even have a ready name. The ethologist Frans De Waal has suggested the somewhat ungainly phrase "anthropodenial" to label this second type of error.[1] Will this phrase take hold as an equal partner of "anthropomorphism," or will one idea remain vivid while the other at best lurks in the shadows?

Although "anthropomorphism" is often defined as an error, it need not be, and the same goes for "anthropodenial." The hypothesis that a nonhuman organism has a psychological trait that human beings possess may or may not be correct, and the same goes for the hypothesis that the organism lacks some trait that human beings have. Suppose that O is a nonhuman organism and we are considering whether O has or lacks a mental characteristic M that we know attaches to human beings. There are two possible states of the world and two possible views we could take concerning whether O has M, thus generating the four possible outcomes depicted in the accompanying table. Mistakenly accepting that O has M is called a "type-1 error"; mistakenly denying that O has M is a "type-2 error." Scientists often take pains to avoid the type-1 error of mistaken anthropomorphism, but

they often seem less concerned about avoiding the type-2 error of mistaken anthropodenial. Why?

This question can be posed both sociologically and logically. The former construal of the question would lead us to consider the cultural factors that have produced this unequal emphasis in scientific thinking. A full discussion of the historical development of science's wariness about anthropomorphism is a project much larger than I can undertake here. However, I do want to note that the type-1 error of mistaken anthropomorphism is often taken to reflect a kind of tenderheartedness, whereas the type-2 error of mistaken anthropodenial is supposed to reveal a kind of tough-mindedness. Supposedly, it is mere sentimentality to think that your pet has mental states, but it is a sign of strength, not weakness, to resist this temptation. Emphasis on the error of anthropomorphism and a relative lack of attention to the opposite error is part of a more general pattern in scientific culture in which tough-mindedness is valued.[2]

In this essay, I want to discuss an important episode in the development of science's asymmetric attitude towards anthropomorphism and anthropodenial. My approach will be both historical and conceptual. Psychologists have for a long time guarded against the risk of anthropomorphism by invoking a methodological principle that the nineteenth century comparative psychologist C. Lloyd Morgan stated and defended in his *Introduction to Comparative Psychology*: "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 the exercise of one which stands lower in the psychological scale."[3] Morgan called this his "canon," and the name has stuck. Morgan gave an interesting defense of his principle, which I'll describe and evaluate.

TABLE 4.1

		Possible states of the world	
		O lacks M	*O has M*
Possible conclusions one might draw	*Deny that O has M*	valid anthropodenial	type-2 error
	Accept that O has M	type-1 error	valid anthropomorphism

To understand Morgan's canon historically, we must understand what Morgan was reacting *against*. Darwin had argued for the mental continuity of human and nonhuman organisms. His chosen successor, George Romanes, continued to emphasize this idea. Darwin's objective was to show that evolutionary ideas apply to mental characteristics no less than they apply to morphological and physiological traits. If all living things are related genealogically, we can locate the emergence of novelties in the interior branches of phylogenetic trees in which the tips represent current species and interior nodes represent common ancestors. Given the fact of common ancestry and the gradualism that was part of Darwin's conception of natural selection, contemporary species should exhibit similarities.[4] Bringing this evolutionary point of view to bear on mental phenomena therefore meant that psychological continuities had to be found between human beings and the rest of nature.

Darwin and Romanes developed this point about psychological evolution by relating anecdotes about animal behavior that were saturated with anthropomorphism.[5] For example, in chapter 2 of *The Descent of Man*, Darwin tells stories about animal behavior to support the claim that language, self-consciousness, an aesthetic sense, and belief in God are qualitatively similar (though not identical) with mental faculties found in nonhuman organisms. Here is a characteristic passage:

> The tendency in savages to imagine that natural objects and agencies are animated by spiritual or living essences, is perhaps illustrated by a little fact which I once noticed: my dog, a full-grown and very sensible animal, was lying on the lawn during a hot and still day; but at a little distance a slight breeze occasionally moved an open parasol, which would have been wholly disregarded by the dog, had any one stood near it. As it was, every time that the parasol slightly moved, the dog growled fiercely and barked. He must, I think, have reasoned to himself in a rapid and unconscious manner, that movement without any apparent cause indicated the presence of some strange living agent, and no stranger had a right to be on his territory.[6]

Morgan also wished to uphold the evolutionary hypothesis that all life is genealogically related, but he saw that the case for evolution does not require one to gloss over the differences that separate human beings and the rest of nature. One branch of a phylogenetic tree can develop novelties that do not emerge in others; a shared genealogy does not require that there be no qualitative differences among the traits exhibited by related species.[7]

Although this insight of Morgan's accords well with a modern evolutionary point of view, there is something decidedly *un*modern about

Morgan's ideas on the foundations of psychology. Like many psychologists writing at the time, Morgan maintained that attributing mental states to others depends on an introspective examination of one's self. When I raise a cup to my lips, this is because I believe that the cup contains a palatable liquid that I desire to drink. When I see another human being perform the same action, I infer a similar mental cause. Morgan saw that this pattern of inference extends across species boundaries. What Morgan termed the "double inductive method" leads one to interpret the behavior of organisms in other species as stemming from the same causes that move human beings to action. However, Morgan did not conclude that this induction *justifies* anthropomorphism—on the contrary, he thought it gives rise to a *bias*—the bias of anthropomorphism.

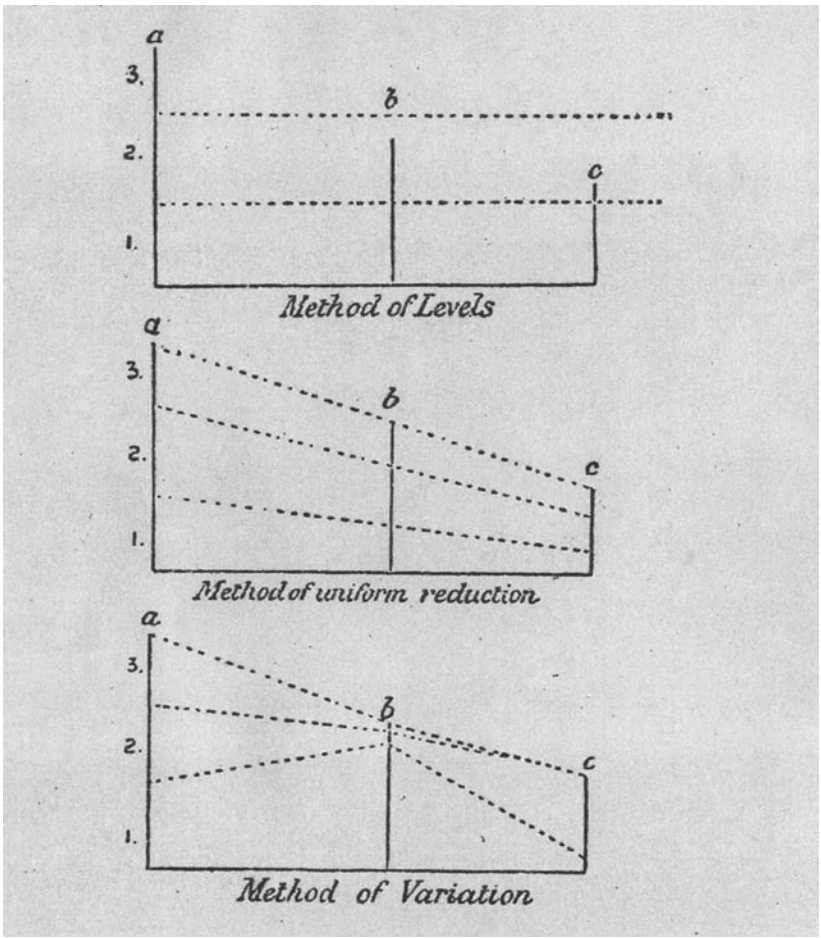
This bias requires a counterbalance, and that was the role that the canon played in Morgan's thought.[8] Morgan believed that the *simplest* hypothesis would be that other organisms are just like us. If I drink water because I believe that water is thirst quenching and want to stop being thirsty, then the simplest inference is that other organisms drink water for the very same reason.[9] It is Morgan's canon that leads one to ask whether drinking behavior in other species can be explained by a psychological mechanism that is "lower" than the beliefs and desires that animate human beings. If the behavior *can* be so explained, then it *should* be so explained. We should conclude that other organisms are *not* like us psychologically. The proximate mechanism that causes drinking in human beings differs from the mechanisms at work in other organisms.

Seen in this historical context, it is evident that Morgan's canon served a useful function; it provided a needed corrective to naive anthropomorphism. The effect of using the canon is that the chance of type-1 error is reduced. However, this point is not enough to justify the canon. After all, type-2 error is error too. Although the canon helps one avoid the bias of anthropomorphism, the question needs to be asked as to whether the canon introduces an opposite bias of its own. If nonhuman organisms really *are* like us in certain respects, the canon may lead us to miss this fact about nature. The canon would not make sense if it merely avoided one bias by falling prey to another.[10]

Morgan did not claim that the canon is justified simply because it reduces the chance of type-1 error. Rather, he argues that the canon has a specifically evolutionary justification. He formulates the problem of justification by asking the reader to consider three "divergently ascending grades of organisms." Species *a*, which represents man, has ascended to a higher level than *b*, which represents dogs, and *b* has risen higher than some other species, *c*. Each of these organisms may exhibit to some degree each of three "ascending facul-

ties or stadia in mental development," numbered 1, 2, and 3. For example, 2 might be sense perception, and 3 might be the ability to reason abstractly. How much will these three faculties be developed in the three species? Morgan describes three possible patterns by which psychological faculties might be distributed across the three species; he called each distribution pattern a "method." I've reproduced his graphical representation (Morgan, *An Introduction to Comparative Psychology*, 56) of the problem in figure 1.

Morgan calls the first possibility the "Method of Levels." Here, "the faculties or stadia are of constant value. In the diagram, *b* has not quite



4.1 The three "methods" that Morgan discusses whereby three mental faculties (1, 2, 3) might be distributed among three species (a, b, c).

reached the level of the beginning of the third or highest faculty, while *c* has only just entered upon the second stadium" (57). The method of levels apparently says that an organism must attain a certain level of development of a lower faculty before it can have any trace whatever of a higher faculty. The second alternative Morgan dubs the "Method of Uniform Reduction." In this arrangement, "in both *b* and *c* we have all three faculties represented in the same ratio as in *a*, but all uniformly reduced" (57). The idea here is that a lower organism has all the faculties that a higher organism possesses but has them developed to a lesser extent. The third alternative is the "Method of Variation," "according to which any one of the faculties 1, 2, or 3, may in *b* and *c* be either increased or reduced relative to its development in *a*" (57). This pattern seems to be the least constraining of the three; evidently, the method of variation is the method of *anything goes*. Morgan summarizes how these methods differ by asking us to suppose that

> *b* represents the psychic stature of a dog. Then, according to the interpretation on the method of levels, he possesses the lowest faculty (1) in the same degree as man; in faculty (2) he somewhat falls short of man; while in the highest faculty (3) he is altogether wanting. According to the interpretation on the method of uniform reduction he possesses all the faculties of man but in reduced degree. And according to the interpretation on the method of variation he excels man in the lowest faculty, while the other two faculties are both reduced but in different degrees. (57)

Morgan then asserts that the process of evolution by natural selection entails that "it is the third method . . . which we should expect *a priori* to accord most nearly with observed facts." He notes that "in the diagram by which the Method of Variation is illustrated, the highest faculty 3 is in *c* reduced to zero;" the total absence of higher faculties in lower organisms is entirely possible. This point allows him to bring his argument for the canon to its conclusion. If the method of variation is correct, then "any animal may be at a stage where certain higher faculties have not yet been evolved from their lower precursors; and hence we are logically bound not to assume the existence of these higher faculties until good reasons shall have been shown for such existence" (59). It is here that we can see the slippage in Morgan's logic. The method of variation does say that it is possible for an organism to have lower but not higher faculties. However, the method also allows for the possibility that an organism will have a higher faculty but not a lower one and also for the possibility that it will have both. Given that Morgan's canon instructs us to take an *asymmetric* attitude towards

anthropomorphism and anthropodenial, the principle cannot be justified by the method of variation, which postulates *no asymmetry at all* in the evolutionary process.

Notice the exact wording that Morgan chooses; he says that "we are logically bound *not to assume the existence* of these higher faculties" without evidence for their existence. But what he needs to show is that we are logically bound to assume the nonexistence of these higher faculties if we lack evidence for their existence. Not assuming the existence of something (agnosticism) is a different matter from assuming its nonexistence (atheism). The wording that Morgan chooses is unobjectionable if we interpret it carefully; indeed, it is just an instance of the general claim that we should not assume the existence of *anything* unless we have evidence. However, this wording does not entail an asymmetry between higher and lower; it would be equally correct to say that "we are logically bound not to assume the existence of *lower* faculties" in a nonhuman organism without evidence for their existence. Modern comparative psychologists sometimes put this point by saying that absence of evidence is not the same as evidence of absence.

In addition to this gap in Morgan's reasoning, it also is unclear what Morgan means by "lower" and "higher." He applies these predicates both to species and to mental faculties. Human beings are "higher" than dogs, and abstract reasoning is a "higher" faculty than sense perception. Morgan's graphical representations give the impression that the "highness" of a species is the sum of the degrees of development of its separate faculties; however, Morgan never describes how these faculties can be rendered commensurable and then summed. If human beings have a greater ability in abstract reasoning than dogs, while dogs have greater sensory acuity than human beings, which species is "higher" overall?

Given that Morgan thought of himself as bringing Darwinian considerations to bear on comparative psychology, one might hope to find some help on this problem in Darwinian theory itself. However, here it is worth reflecting on the fact that Darwin once wrote himself a memo to never say "higher" and "lower."[11] This was no mere passing scribble; it characterized a deep and enduring implication of the hypotheses that Darwin developed. The theory of evolution by natural selection undermines the idea of a linear scale of nature in which each stage is higher or lower than every other. Darwin replaced the ladder with the tree; lineages diverge from each other and develop different adaptations that suit them to their peculiar conditions of life. In this framework, it makes no sense to ask whether one contemporary species is higher or lower than another.[12]

Morgan was very much in the grip of the Spencerian doctrine that evolution always marches from simple to complex.[13] To the degree that

the canon depends on this claim of directionality, the canon is in trouble. Although life started simple and thus had to show a net increase in complexity (it had nowhere to go but up), the history of life is peppered with cases of evolutionary simplification. For example, the evolution of parasites typically involves a transition from complex to simple as the parasite loses features found in its free-living ancestor. And even if we assume that evolution always moves from simpler to more complex traits, it still is unclear why human beings are "higher" than dogs. After all, we are not descended from present-day canines; rather, we and they have a common ancestor. The Spencerian idea guarantees only that descendants are "higher" (that is, more complex) than their ancestors.

Perhaps the closest that modern Darwinian theory comes to the distinction between "higher" and "lower" is the distinction between derived and ancestral character states. A lineage begins with a certain suite of characters, which we can call "the ancestral condition." When novelties evolve, we say that the new forms introduced into the lineage are "derived." It is left entirely open whether the derived form of a character is more complex than the ancestral form. In fact, the distinction between ancestral and derived characters is always relative to the portion of a lineage that one is considering. For example, consider a lineage in which species X is ancestral to species Y and Y is ancestral to species Z. Suppose that X lacks wings, Y has wings, and Z has no wings. If we are considering the portion of this lineage that goes from X to Y, winglessness is the ancestral condition; however, if we wish to talk about the part that goes from Y to Z, then wings are ancestral and winglessness is derived. Although it is easy to take on board the idea that the ancestral/derived distinction depends on which lineage one is discussing, it is perhaps less than intuitive to say that the lower/higher distinction has this sort of relativity. Given this, it is perhaps not surprising that "lower" and "higher" have largely lapsed from the language of evolutionary biology.

The question I now wish to explore is whether Morgan's canon makes sense when "higher" and "lower" are replaced with "derived" and "ancestral." What is the status of the following "modernized" version of Morgan's canon:

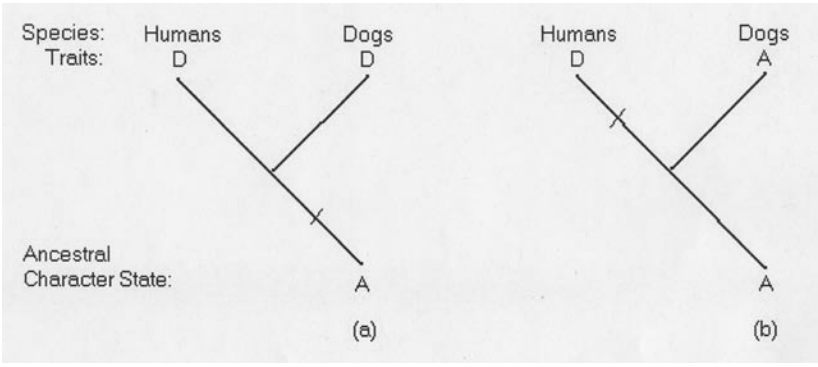
> In no case may we interpret an action as the outcome of the exercise of a derived psychical faculty, if it can be interpreted as the outcome of the exercise of an ancestral faculty.

Let's begin exploring this question by considering the problem depicted in figure 2. Here we see human beings and dogs as two tip species in a phylogenetic tree. We assume that the species at the root of the tree has the ancestral

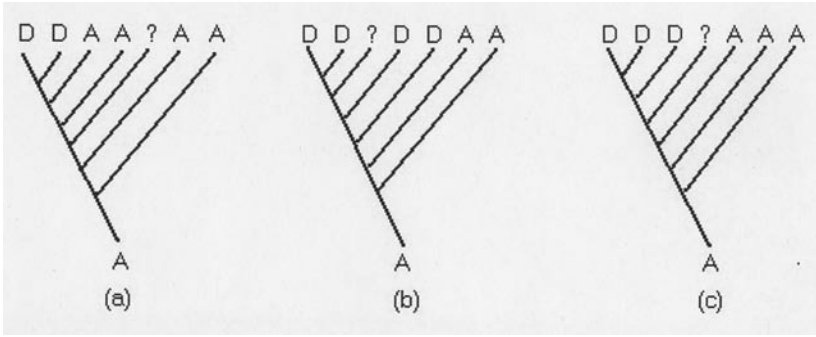
state A and that human beings have the derived form D of the character. Our question is whether we should attribute D or A to dogs. This problem can be analyzed by using a standard idea in evolutionary biology—that the plausibility of rival hypotheses can be evaluated by considering how parsimonious they are. In this context, parsimony is measured by seeing how many changes in character state would have to occur under each of the competing hypotheses.[14] This way of thinking about parsimony is sometimes called "cladistic parsimony," to indicate that it is a principle that is specifically about phylogenetic trees ("clade" comes from the Greek word for "branch"); its connection with the broader and vaguer principle of parsimony (aka "Ockham's razor") is a matter of continuing discussion.

The point to notice about figure 2 is that the two possible assignments of character state to dogs are equally parsimonious. Whether we say that dogs have D (figure 2a) or that they have A (figure 2b), at least one change in character state must have occurred in the branches of the evolutionary tree. The location of this change is indicated by a "slash" through the relevant branch in the phylogenetic tree. In the problem we are considering, the modernized formulation of Morgan's canon is false—assigning dogs the ancestral character state is neither more nor less plausible than assigning them the derived state.

The analysis gets a little more complicated if we have additional information about the characteristics of species other than human beings. For example, in the three problems depicted in figure 3, we begin with information about the characteristics of human beings and other species, and we



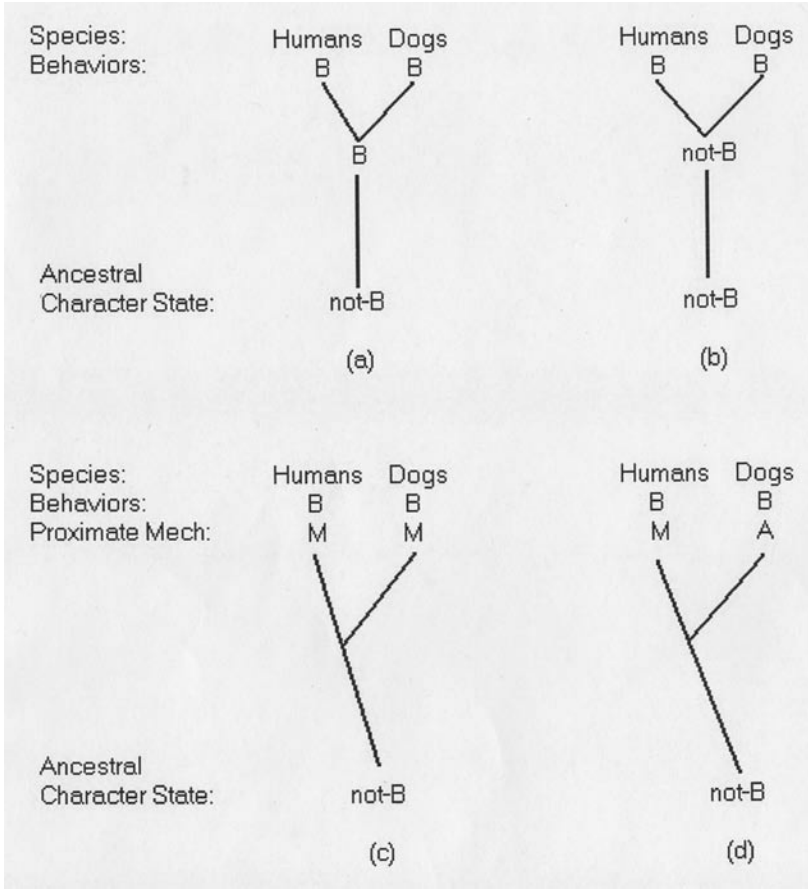
4.2 Given just that human beings have the derived character state D, (a) assigning the derived character state D to dogs and (b) assigning the ancestral character state A to dogs are equally parsimonious. Cladistic parsimony does not discriminate between anthropomorphism and anthropodenial in this instance.



4.3 Assuming that human beings (the left-most tip species in each tree) have the derived character state D, different assignments of character states to dogs—the species indicated by the question mark—can sometimes differ in parsimoniousness if one has additional knowledge of the character states of other, related species. See the text for details.

wish to use parsimony to assign a character state to dogs. In figure 3a, it is more parsimonious to hypothesize that dogs have the ancestral character state. In figure 3b, parsimony favors assigning the derived character state to dogs. In figure 3c, the two possible assignments are equally parsimonious. However, the inferences represented in figures 3a and 3b are not available in the problem we have been considering. In that problem, we are supposed to begin with just one "observation"—that human beings have the derived character state.[15] As we saw in figure 2, that single datum provides no help in deciding which character state to attribute to dogs.

All is not lost, however, in that cladistic parsimony *does* provide advice about a slightly different problem, which is depicted in figure 4.[16] Let's suppose that human beings and dogs are both observed to exhibit some derived *behavior* B. This means that the root of the tree is in the state not-B. Parsimony favors regarding B as a homology (figure 4a) rather than as a homoplasy (figure 4b). A homology is a similarity inherited from a common ancestor; a homoplasy is a similarity that is the result of two or more independent derivations of the trait. So far we have said nothing about the proximate mechanisms (psychological or otherwise) that might be causing dogs and humans to produce this behavior. Let's call the psychological mechanism that human beings use to produce the behavior M, and let's suppose that an alternative mechanism, A, also could produce the behavior. Our question is whether we should attribute M or A to dogs. The two possibilities are depicted in figures 4c and 4d. Since the root of the tree is assumed to lack the behavior B, it follows that neither M nor A is present



4.4 If human beings and dogs both exhibit a derived behavior B, then it is more parsimonious (a) to view the shared behavior as a homology than (b) to hypothesize that it evolved independently in the two lineages. In addition, it is more parsimonious (c) to conjecture that human beings and dogs produce the behavior by using the same proximate mechanism M than (d) to claim that human beings and dogs deploy different proximate mechanisms.

ancestrally. Given all this, it turns out that assigning M to dogs (4c) is more parsimonious than assigning A to dogs (4d). Parsimony, in this instance, favors anthropomorphism, just as Morgan claimed.

It is important to understand this conclusion in the right way. Cladistic parsimony does not provide a blanket justification for attributing human characteristics to nonhuman organisms. This is the lesson of figure 2. However, figure 4 represents a more specific problem in which parsimony does

favor anthropomorphism over anthropodenial. *If two derived behaviors are homologous, then the hypothesis that they are produced by the same proximate mechanism is more parsimonious than the hypothesis that they are produced by different proximate mechanisms.*

An interesting feature of Morgan's canon is that it accords no special status to psychological characteristics. For Morgan, mental traits can be "higher" or "lower," but so too can features of respiration and digestion. Morgan's canon is a principle of comparative *biology*, not just of comparative *psychology*. In this sense, the cladistic analysis I have described is very much in the spirit of Morgan's approach. The principle of cladistic parsimony applies to any trait that evolves—to traits about the mind no less than to traits about digestion and respiration. However, once Morgan's terms "lower" and "higher" are replaced with the more scientifically coherent concepts of "ancestral" and "derived," the argument leads to a conclusion that differs from Morgan's. There is no presumption in favor of treating human beings as different from the rest of nature; on the contrary, there is a circumstance in which the presumption is precisely in the opposite direction.

Morgan's canon, in the modernized formulation I have supplied, conflicts with cladistic parsimony, but that does not settle whether cladistic parsimony is a valid principle of evolutionary reasoning. As noted, it is a principle that is widely used in evolutionary biology, though it must be added that its status is at present a matter of scientific debate. But regardless of the outcome of that debate, it seems clear that nothing like the reformulation of Morgan's canon that I have discussed will find a justification in evolutionary theory. There is no evolutionary presumption in favor of assuming that nonhuman organisms differ from human beings, either in terms of their mental or their nonmental characteristics.

Even though evolutionary theory offers no justification of Morgan's canon, it is possible that something like his principle can be given a nonevolutionary justification. Contemporary ethologists often invoke a "principle of conservatism," according to which we should prefer attributing "less sophisticated" abilities to nonhuman organisms over "more sophisticated" abilities when both would suffice to explain the behavior we observe.[17] Whether this principle discards Morgan's categories of "higher" and "lower" or merely supplies them with new labels is a question worth asking. Although it is not clear what "degrees of sophistication" means here, the use that ethologists make of the principle renders two of its elements unambiguous. The first is that attributing a nonmental faculty to an organism is supposed to be preferable to attributing a mental faculty when both are consistent with the observed behavior. And within the category of

mentalistic explanation, attributing fewer mental abilities to an organism is supposed to be preferable to attributing more. Contemporary ethologists, unlike Morgan, do not attempt to provide an evolutionary justification of their principle. In fact, they usually do not discuss what justifies it at all; they merely rely on its being intuitive.

Morgan's canon (both in Morgan's own formulation and in the one that uses the evolutionary concepts of derived and ancestral characters) and the principle of conservatism are maxims of "default reasoning." They say that some hypotheses should be presumed innocent until proven guilty, while others should be regarded as having precisely the opposite status. Perhaps these default principles deserve to be swept from the field and replaced by a much simpler idea—that we should not indulge in anthropomorphism *or* in anthropodenial until we can point to observations that discriminate between these two hypotheses. It is desirable that we avoid the type-1 error of mistaken anthropomorphism, but it also is desirable that we avoid the type-2 error of mistaken anthropodenial. However, the best way to minimize the risk of *both* types of error is not to embrace an a priori prejudice. The only prophylactic we need is empiricism.[18]

NOTES

1. F. De Waal, "Anthropomorphism and Anthropodenial: Consistency in our Thinking About Humans and Other Animals," *Philosophical Topics* 27 (1999): 255–80.

2. Another application of the distinction between tough-mindedness and tendermindedness in science that William James drew in his book *Pragmatism* may be found in the ongoing debate in evolutionary biology concerning group selection. Those sympathetic to group selection are often portrayed by their critics as naive sentimentalists who see nature through rose-colored glasses; those same critics congratulate themselves on their willingness to stare nature's dark side full in the face. For discussion, see E. Sober and D. Wilson, *Unto Others: The Evolution and Psychology of Unselfish Behavior* (Cambridge, Mass.: Harvard University Press, 1999).

3. C. Lloyd Morgan, *An Introduction to Comparative Psychology,* 1st ed. (London: Walter Scott, 1894), 53. In the book's second edition Morgan rephrases the canon and then adds an important clarification; C. Lloyd Morgan, *An Introduction to Comparative Psychology,* 2nd edition, (London: Walter Scott, 1903): "To this, however, it should be added, lest the range of the principle be misunderstood, that the canon by no means excludes the interpretation of a particular activity in terms of the higher processes if we already have independent evidence of the occurrence of these higher processes in the animal under observation."

4. For a more detailed examination of how the ideas of common ancestry and natural selection interact in evolutionary theory, see E. Sober and S. Orzack,

"Common Ancestry and Natural Selection," *Britsh Journal for the Philosophy of Science* 54 (2003): 423–37.

5. R. Richards, *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago: University of Chicago Press, 1987).

6. Darwin, *The Descent of Man, and Selection in Relation to Sex* (1871; reprint, Princeton, N.J.: Princeton University Press, 1981), 1:67.

7. G. Gottlieb, "Comparative Psychology and Ethology," in *The First Century of Experimental Psychology*, ed. E. Hearst (Hilldale, N.J.: Lawrence Erlbaum, 1979), 150.

8. G. Burghardt, "Animal Awareness: Current Perceptions and Historical Perspective," *American Psychologist* 40 (1985): 912.

9. Even though Morgan thought that his canon *conflicted* with the principle of parsimony, his successors took precisely the opposite position, usually without even pointing out that their understanding of the canon differed from Morgan's. For example, B. Skinner, *The Behavior of Organisms* (New York: Appleton Crofts, 1938), 4, says "Darwin, insisting upon the continuity of mind, attributed mental faculties to subhuman species. Lloyd Morgan, with his law of parsimony, dispensed with them in a reasonably successful attempt to account for characteristic animal behavior without them." E. Boring, *History of Experimental Psychology* (New York: Appleton Century Crofts, 1950), 474, also says that the canon is a version of the razor but denies that the principle of parsimony is legitimate when the problem is to infer the mental capacities of nonhuman organisms. "Nature is notoriously prodigal," according to Boring, so "why should we interpret it only parsimoniously?" It is an interesting historical problem why Morgan's canon was transformed from a specifically Darwinian principle to a general methodological maxim and an interesting epistemological question whether this reformulation allows the principle to be justified.

10. Consider, for example, a principle that is the mirror image of Morgan's canon—that we should attribute higher mental faculties rather than lower ones, when both would account for the data. This maxim reduces the chance of type-2 error.

11. M. Ghiselin, *The Triumph of the Darwinian Method* (Berkeley: University of California Press, 1969), 70.

12. This is not to say that Darwin disavowed the idea of evolutionary progress; see D. Ospovat, *The Development of Darwin's Theory* (Cambridge: Cambridge University Press, 1981), chapter 9. Sober discusses modern evolutionary theory's attitude towards this concept; see E. Sober, "Progress and Direction in Evolution," in *Progressive Evolution?* ed. J. Campell (Boston: Jones and Bartlett, 1994), 19–33; see also the essays in Matthew H. Nitecki, ed. *Evolutionary Progress* (Chicago: University of Chicago Press, 1988).

13. Gottlieb, "Comparative Psychology," 150; Boakes, *From Darwin to Behaviorism: Psychology and the Minds of Animals* (Cambridge: Cambridge University Press, 1984), 40.

14. For discussion, see E. Sober, *Reconstructing the Past: Parsimony, Evolution, and Inference* (Cambridge, Mass.: MIT Press, 1988); and E. Sober, "Reconstructing the Character States of Ancestors: A Likelihood Perspective on Cladistic Parsimony," *The Monist* 85 (2002): 156–76.

15. None of us "observes" that *all* human beings have a given mental trait. The problem of why we are entitled to extrapolate across species boundaries also applies within our own species, as Morgan recognized; this is the setting of the traditional philosophical problem of other minds; see E. Sober, "Evolution and the Problem of Other Minds." *Journal of Philosophy* 97 (2000): 365–86.

16. This argument is presented in F. De Waal, "Complementary Methods and Convergent Evidence in the Study of Primate Social Cognition" *Behaviour* 118 (1991): 297–320, and is further discussed in E. Sober, "Evolution and the Problem of Other Minds."

17. See, for example, D. Cheney and R. Seffarth, *How Monkeys See the World* (Chicago: University of Chicago Press, 1990).

18. E. Sober, "The Principle of Conservatism in Cognitive Ethology," In *Naturalism, Evolution, and Mind*, ed. D. Walsh (Cambridge; Cambridge University Press, 2001), 225–38.