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Journal

International Journal of Comparative Psychology, 18(3)

ISSN

0889-3675

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Publication Date

2005-12-31

DOI

10.46867/ijcp.2005.18.03.06

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Peer reviewed

The Modern Role of Morgan's Canon in Comparative Psychology

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C. Lloyd Morgan is widely credited as the "father of comparative psychology" due to his contribution of guidelines for the psychological interpretation of animal behavior. Many modern comparative psychologists believe that constraints encouraged by Morgan are now obsolete and some assert that adherence to the canon restricts further progress in the field. Nonetheless, Morgan's guidance continues to be important in comparative psychology. A review of Morgan's canon, its historical misuse, and consideration of popular alternatives reinforce Morgan's role in comparative psychology. A recent model of cognitive evolution highlights the importance of Morgan's guidelines and an illustration of the continued usefulness of the canon is given in the context of investigations of theory of mind in chimpanzees.

The statement of C. Lloyd Morgan, "in no case may we interpret an action as the outcome of the exercise of a higher psychological faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale" (Morgan, 1894, p. 53), is one of the most well known principles in all of comparative psychology. Although Morgan was not the first to apply psychological questions to animal subjects (i.e., Darwin, 1872; Romanes, 1882), he has earned the title, "father of comparative psychology" for his influence. While Morgan's canon continues to be taught as a basic part of the comparative psychology curriculum, it is often considered to be too restrictive and is ignored, or is invoked incorrectly in practice. A paraphrase of the incorrect modern interpretation of the canon is, "Accept the theory that provides the simplest explanation for the observed phenomenon" (see Griffin, 1976, for a similar statement). This misstatement is a conflation of three separable principles: Occam's razor, Hamilton's law of parsimony, and Morgan's canon. Before discussing the role of Morgan's canon, it would be beneficial to clarify what the canon means and to show how it differs from its intellectual predecessors.

Historical Perspective

Occam's razor is a medieval minimalist philosophical principle attributed to William of Occam, the man first credited with making this statement in the fourteenth century: "*Pluralitas non est ponenda sine neccesitate*" or "plurality should not be posited without necessity" (Carroll, 2003). This statement counsels against postulating the existence of unnecessary causes in the discussion of metaphysical

This writing was supported by a base grant to the Cognitive Evolution Group from the State of Louisiana. I thank Dr. Daniel Povinelli for extensive inspiration and guidance in the writing of this paper. I also thank Dr. Jennifer Vonk, Dr. Roger Thomas, Dr. Beth Losiewicz, and an anonymous reviewer for their helpful comments on earlier versions of this paper. Correspondence concerning this article should be addressed to M. Rosalyn Karin-D'Arcy, Cognitive Evolution Group, University of Louisiana at Lafayette, 4401 W. Admiral Doyle Drive, New Iberia LA 70560 U. S. A. (ceg@louisiana.edu).

phenomena. In the nineteenth century, Sir William Hamilton (1856, p. 580) adapted Occam's razor to the application of theories about natural phenomena:

Without descending to details, it is manifest in general, that against the assumption of a special principle, which this doctrine makes, there exists a primary presumption of philosophy. This is *the law of parsimony; which prohibits, without a proven necessity, the multiplication of entities, powers, principles or causes; above all, the postulation of an unknown force where a known impotence can account for the phenomenon*. We are, therefore, entitled to apply "Occam's razor" to this theory of causality, unless it be proved impossible to explain the causal judgment as a cheaper rate, by deriving it from a common, and that a negative, principle. On a doctrine like the present, is thrown the burthen of vindicating its necessity, by showing that unless a special and positive principle be assumed, there exists no competent mode to save the phenomenon. The opinion can therefore only be admitted provisorily; and it falls, of course, if what it would explain can be explained on less onerous conditions. [Emphasis added.]

Simply put, Occam's razor and Hamilton's law of parsimony counsel that when explaining a metaphysical or natural phenomenon, one should take care to not postulate a theoretical entity that need not exist. These principles, which are the philosophical parent and grandparent of Morgan's canon, are useful in every field of science and philosophy. Morgan's adaptation of these principles is specifically addressed to comparative psychologists, and is applicable across cognitive and developmental psychology research pursuits.

Morgan originally published the canon in his *Introduction to Comparative Psychology* (1894). This work played a major role in establishing comparative psychology as a science by introducing criteria for the attribution of psychological states to animals. Only a fragment of Morgan's original statement, quoted above, is usually found in comparative psychology texts, placing his lesson out of context and contributing to the misunderstanding of the principle. Morgan intended the canon to encourage comparative psychologists, through careful introspection, to attend to the levels of the functioning of human minds so that the activities of other species could be matched with the *appropriate* human functions, not those first intuited.

Morgan's teachings have been confounded with the turn-of-the-century behaviorist literature (as by Griffin, 1976), and thus have been widely misinterpreted as disallowing the attribution of human mental characteristics to nonhuman animals (reviewed by Thomas, 2001b). In fact, Morgan's assumption that the continuum of mental functions experienced by humans would be the same, except perhaps truncated, in other species is itself a cognitivist and an anthropomorphic claim. The complete statement of Morgan's canon provides a clearer sense of what Morgan intended than does the briefer, but more often-quoted phrase. Morgan (1894, p.59) wrote,

...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. In other words, we are bound to accept the principle above enunciated: that in no case is an animal activity to be interpreted as the outcome of the exercise of a higher psychical faculty, if it can be fairly interpreted as the outcome of the exercise of one which stands lower in the psychological scale.

The influence of Hamilton's (1856) law of parsimony is clear in Morgan's insistence to not *assume* the existence in nonhuman species of "higher faculties" attributed to humans. It can be difficult to distinguish between the advice given by

the law of parsimony and Morgan's canon, but attention to the philosophical context in which each was developed can aid in their discrimination. The law of parsimony is concerned with explaining observed phenomena by hypothesizing new entities. Hamilton advises that explanation should be attributed to "common" principles unless they are insufficient for the observed phenomenon. Applied to comparative psychology, "entities" are representational forms, and "common principles" are mechanisms shared among the greatest number of species or among species in an inclusive taxonomic category (i.e., *primate* rather than *human*). One example in comparative psychology to which the law of parsimony may be applied is the introduction of the concept of "emergents" to characterize relational learning mechanisms seen to require more than operational or associative learning, but without necessitating that there be some innate propensity for an organism to acquire a particular kind of knowledge (Rumbaugh & Washburn, 2003; Rumbaugh, Washburn, & Hillix, 1996). Rumbaugh and his colleagues go to great length to explain how emergents differ from traditionally discussed learning mechanisms, but it is a question of parsimony whether such a construct is helpful to an understanding of cognition (Thomas, 2001a). Morgan's canon, in contrast, deals with a set of psychological processes induced from the study of humans, and the attribution of those processes to nonhuman animals. The difference here is the attribution of faculties that are believed to exist in one species, but perhaps do not exist in all species.

Misinterpretation of Morgan's canon began immediately upon its publication, prompting Morgan (1903, p. 59) to include a revised statement in the second edition of his book:

In no case is an animal activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development. 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.

This objective study of behavior advocated by Morgan involves what he saw as a dubious double-induction process deemed necessary based on the recognition that our only frame of reference for mental activity is our own mental experience. Morgan teaches that we first induce, through introspection, the human mental processes associated with an interesting behavior. In doing this, we must move beyond our intuitive impressions of our mental activity and decompose mental tasks into components. The second induction makes interpretations of animal behaviors in terms of those induced human mental processes (Morgan, 1903). Both acts of induction should be executed carefully, taking care not to over-attribute mental processes for the behaviors observed.

Let us take as an example the attribution of mental processes involved in a simple behavior encountered in the context of driving a car through city streets: "go on green." The implementation of this cultural rule may occur at several levels. One source of the behavior may be the interpretation and implementation of conceptually rich meaning behind green traffic lights: a green light is a signal that the cross traffic is stopped and it is now safe to go. Therefore, a driver will move the car forward given a green light and a clear path. Another source of the rule may be a learned traffic schema which dictates expectations and acceptable behavior

when encountering a green traffic light. Either of these explanations for “go on green” behavior provides a reasonable description of possible mental processes governing adherence to the rule. But consider this description based on simple operant conditioning: when stopped and presented with a green light and a clear path ahead, drive forward or else you will be punished by the honking of other drivers. Any of these three cognitive mechanisms, or a combination of them, could result in the observed behavior of a driver “going on green.” However, how would you begin to attribute any one of these to a particular observed driver, much less a non-human animal performing an analogous task? It is in interpretive situations such as this one that Morgan’s canon advises the acceptance of the most general cognitive mechanism reasonable as an explanation of the behavior when making an attribution of cognitive ability. Further tests of drivers’ behaviors would be necessary to rule out the more general mechanism as an explanation in favor of a more specialized cognitive mechanism.

Despite periodic reminders of Morgan’s intent behind the canon and clarification of misrepresentations found rampant in modern comparative psychology (Carroll, 2003; Costall, 1993; Thomas, 2001b; Wozniak, 1997), misrepresentations of the canon continue directly and indirectly to misguide research in the field.

Alternative Strategies for Mental Attribution

One of the stated goals of the study of animal behavior is to define basic or elemental learning processes (Domjan, 1993), that is, processes shared among diverse species which form the basis of all learning. As an alternative to following this traditional program of animal behavior research, many comparative psychologists engage in a direct comparison between humans’ and other species’ cognitive processes, adopting an anthropocentric approach. Both areas of research are important in the general study of mind and cognition, and both benefit from Morgan’s teachings. In the process of making explicit comparisons between humans and other species, cognitive processes used by a wide range of species are commonly overlooked in favor of processes studied first in humans. This shift in base theoretical model, from phylogenetic to anthropocentric, may be due to a greater understanding of human psychology over that of other species. Two alternatives to Morgan’s canon, an appeal to simplicity and an adherence to human analogy for animal behavior, are widely used in comparative psychology. In some cases these arguments are preferred in their own right and sometimes are presented as misinterpretations of the canon itself.

Simplicity

Use of a simplicity rule takes many forms and each has its own pitfall. Simplicity is often used as an appeal to “parsimony,” although a criterion of simplicity is not actually included in Hamilton’s law of parsimony or Morgan’s canon. In this form, simplicity may mirror Morgan’s canon in advocating the most basic, or “simplest,” explanation for observed behaviors.

Further appeals to simplicity may take the form of arguments for cognitive economy, that is, conceptualization processes resulting in the reduction of the amount of information that must be learned, perceived, or remembered, therefore

simplifying cognitive processing (Eysenck & Keane, 1995). This position asserts that a system that provides the most cognitive economy would be the most adaptive, and therefore offers the best explanation. For example, Whiten (1996) describes a hypothetical cognitively economic system of “explicit mentalism” whereby a mental state is explicitly encoded in the mind of an observer as an intervening variable in the cause of observed behavior. Cognitive economy, such as identifying and making use of intervening cognitive variables, may make additional cognitive acrobatics possible, but representing the abstracted concept is not a *simple* matter.

When faced with arguments of cognitive economy, one must remember that systems that economize by abstraction must first process the elements from which the abstractions are built. To illustrate the hierarchical character of economized cognition, let us use a simplistic model: The attribution of the behavioral state of *eating* and the prediction of a particular behavior, *taking a bite*. To predict that a person will take a bite of food because *she is engaged in the act of eating* may seem simpler than to calculate the statistical probability that she will take a bite based on the rate at which she has been taking bites coupled with the amount of food remaining on her plate and whether or not she remains seated at the table. However, the attribution of *eating* is a characterization of the behavioral pattern described, and cannot be made without a system in place that processes the detailed behavioral information.

An appeal to simplicity may favor the theory most easily expressed in natural language, as discussed in Heyes (1998) as the “simpler for us” theory of hypothesis acceptance. In another type of simplicity appeal, de Waal (1991) invokes the criterion of “elegant explanation” as a basis upon which to choose between competing hypotheses. In a so-called elegant explanation, “the number of assumptions and causal steps [is] reduced, and the range of circumstances under which the behavior manifests itself can be better accounted for, by moving up the scale of cognitive assumptions” (de Waal, 1991, p. 306). Dennett (1983) makes a similar argument for use of “the intentional stance” when explaining behavior. This is fine for hypothesis generation, but is dubious as a criterion for accepting a hypothesis.

Finally, some take the simplest model to be the one best understood. In psychology, the human model has been the most studied, and is used as the general model for all animals. De Waal (1991, p. 28) again invokes simplicity as the basis for the attribution of mental states to nonhuman animals using this reasoning:

By far the simplest assumption regarding the social behavior of the chimpanzee, for example, is that if this species’ behavior resembles that of ourselves then the underlying psychological and mental processes must be similar too. To propose otherwise requires that we assume the evolution of divergent processes for the production of similar behavior.

The structure of this simplicity-touting argument is that of the argument by analogy (Hume, 1739/1911; Povinelli & Giambrone, 1999), which will be discussed in detail as the other commonly used alternative to Morgan’s canon. When tempted to fit animal data into the human model, comparative psychologists must remember that lack of the development of an alternative model cannot stand as criterion for acceptance of a well-developed one.

Morgan himself rejected simplicity as a valid criterion for choosing an explanation, although he acknowledged that adherence to his canon could cause one

to overlook the simplest explanation for an observed phenomenon. His rebuttal against advocates of simplicity is similar to those offered here: To attribute higher psychological faculties to animals may seem simpler than to “explain them as the complex result of mere intelligence or practical sense experience...But surely the simplicity of an explanation is no necessary criterion of its truth” (Morgan, 1903, p. 54). Dewsbury (2002) argues that there is a sense in which a simplicity criterion is consistent with Morgan’s canon. He makes the distinction between simple *explanations* and simple psychological *processes*. Following this distinction, “simple faculties” are faculties lower on a hierarchical continuum of cognitive processes. The use of a simplicity criterion in this sense is congruent with Morgan’s canon. However, the difficulty of defining and using the concept of simplicity with any consistency across scientists, across subdisciplines, and across decades warrants caution in the use of the term.

The Argument by Analogy

The argument by analogy, although formalized in the eighteenth century (Hume, 1739/1911), is clearly present in the modern literature, with de Waal (1991) and Dennett (1983) appearing as outstanding representatives of this widely held viewpoint. For example, de Waal (1991, p. 316) asserts, “The most parsimonious assumption concerning nonhuman primates is that if their behavior resembles human behavior the psychological and mental processes involved are probably similar too.” This form of argument is especially popular in discussions of comparative social cognition where there is controversy about whether apes represent other minds. Table 1 gives the form of the argument (based on Povinelli & Giambrone, 1999).

Table 1
The Argument by Analogy.

Premise 1:	I (and other humans) exhibit bodily behavior of type B (which is interpreted in terms of human folk-understanding of our own minds).
Premise 2:	Another animal species (for example, chimpanzees) exhibit bodily behaviors of type B.
Premise 3:	My own bodily behaviors of type B (and those of other humans) are usually caused by my (and other humans’) mental processes of type A.
Conclusion:	Therefore, bodily behaviors of type B exhibited by an animal are caused by their mental processes of type A; and so prove that the animal possesses those mental processes.

In addition to this long history of use of human analogy, basic animal processes are often overlooked as explanations for complex behavior due to the acceptance of the normal adult human as the standard for comparison in the post-Turing test era of cognitive science (Menzel & Johnson, 1978; Turing, 1950). This perspective takes the human model as the basis of comparison and explanation for characteristics displayed by other species, instead of recognizing that humans, like all of the millions of other species, are a special case of animals. This thinking turns Morgan’s canon on its head, preferring higher-level explanations if observations suggest them. Instead of determining the most common psychological process that could account for a phenomenon, the goal in choosing a model of cogni-

tion becomes determining “the highest level explanation that appears reasonable given the species’ general intelligence level” (de Waal, 1991, p. 306).

There is no comparison to which careful choice of base cognitive model is more critical than the comparison between humans and apes. Given their close evolutionary ties, it is expected that humans and apes share fundamental cognitive characteristics (i.e., Antinucci, 1989; Byrne & Whiten, 1988; Parker & McKinney, 1999), but there are certainly areas of mental activity in which either lineage has developed specializations, resulting in the related mental characteristics being different. It is this evolutionary fact of specialization that makes it critical that no single species be taken as a standard by which to match abilities displayed by other species. This highlights a problem in a basic assumption made in human/ape comparisons. As Parker and McKinney (1999, p. 11) point out, “...in scientific studies, anthropomorphism is the null hypothesis...” This attitude places the burden of disconfirmation on experiments limited to small sample sizes and infrequent replication, making anthropomorphism the default conclusion in many cases. The characteristics of the inclusive taxonomic level (i.e., primate, mammal, or animal), and not the possible specialized case, should be taken as the standard (the null hypothesis) when making species comparisons. The sound conclusion to draw from a failure to disconfirm such a null hypothesis is that humans are acting like apes, not the reverse. The behaviors exhibited by members of other species and their underlying cognitive activity must be carefully dissected before making a claim of shared derived mental characteristics among species.

The logical response, and one that de Waal (1991) makes, is to point to a double-standard in scientists’ attribution of cognitive capacities, such as intentionality and self-awareness, to virtually all human social activities while failing to grant these same abilities to nonhuman primates. Some scientist find it “only natural that all members of the primate order, including humans, share fundamental mental characteristics,” (de Waal, 1991, p. 297) and that “mental complexity in nonhuman primates is indeed the most parsimonious explanation of their evident behavioral affinity with ourselves (unless, of course, one feels that human mental abilities are grossly overrated)” (de Waal, 1991, p. 301). In defense of de Waal’s position, in cases where structural similarities and evolutionary continuities are pronounced, “it may make sense for the ethologist to advance attributions of cognitive capacities to nonhumans” (Wilder, 1996, p. 35). Menzel and Johnson (1978, p. 587) agree: “In these sorts of cases, precisely the *opposite* of Morgan’s canon may be in order: ‘Assume until proven otherwise that others are just as intelligent, complicated, and so on, in their own way as you are in yours.’” There is a place for this position in ethology and comparative psychology in the development of hypotheses about complex behaviors. It is an important *starting point* when considering behaviors and developing interpretations. It is important to recognize homologies among species; however, it is equally important to consider derived specializations.

The focus of concern here is awareness of our own evolved mechanism to interpret behavior in mentalistic terms which underlies the process of evaluating observed behavior and hypotheses of mental functioning in other species. This problem is well illustrated in the investigation of chimpanzees’ social understanding (Hare, Call, Agnetta, & Tomasello, 2000; Premack & Woodruff, 1978; Byrne & Whiten, 1988). Several comparative psychology laboratories have generated

convincing evidence that chimpanzees are proficient at following human gaze (Call, Agnetta, & Tomasello, 2000; Krause & Fouts, 1997; Povinelli & Eddy, 1996; Tomasello, Hare, & Agnetta, 1999). Morgan tells us in the final clause of his amended canon, "...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*" (Morgan, 1903, p. 59; emphasis added). This suggests that, given chimpanzees' ability to follow human gaze, we may safely assume that chimpanzees can follow the gaze of conspecifics before testing them for a general gaze-following ability. However, these findings do not give license for the attribution of an understanding of *seeing* to chimpanzees based on the premise that humans gaze-follow and also are proficient at attributing vision to others. The need for caution has been born out in studies which do not support the hypothesis that chimpanzees have an understanding of seeing, such as investigations regarding understanding of the necessity of visual access for elicitation of a response to a visual stimulus (Povinelli & Eddy, 1996; Reaux, Theall, & Povinelli, 1999), or that food hidden from a dominant rival is safer to approach than food that is not hidden (Karin-D'Arcy & Povinelli, 2002). Morgan allows generalizations of cognitive abilities to be made across circumstances within a species, but, unlike the argument by analogy, Morgan does not allow generalization across species within a circumstance.

The argument by analogy has two essential flaws. The first is anthropocentrism. It is clear from the preceding discussion that no species can be assumed to be using presumed cognitive specializations of humans, or other species' specializations, even when the resulting behaviors appear to be similar. The second flaw of the argument by analogy is its reliance on introspection (see also Povinelli, Bering, & Giambrone, 2000; Povinelli & Giambrone, 1999). The central problem with relying on introspective or metacognitive techniques to understand mental activity is that one can not know which of a set of possible cognitive mechanisms was actually used in the execution of a cognitive task. This is illustrated in an argument put forward by Smith and his colleagues (Smith, 2003; Smith, Shields, & Washburn, 2003; Smith & Washburn, 2005). These researchers make an explicit claim that Morgan's canon hinders the progress of comparative psychology using their comparative studies of uncertainty monitoring as a case in point (Smith, 2003, p. 58):

But one can understand...why parsimony seemingly embodied in Morgan's canon is false when applied to data patterns shown here. Humans perform just like monkeys do. Humans are declaratively uncertain as they do so. Humans and monkeys have shared much of their evolutionary histories, especially including the fitness matrices that could have prompted the emergence of an uncertainty-monitoring cognitive system. Humans and monkeys even share homologous brain structures that could provide the neurological substrate for this system. For these reasons it is unparsimonious to interpret the same graph produced by humans and monkeys in qualitatively different ways.

Smith claims that it is scientifically inappropriate to interpret two sets of similar results differently, one with a metacognitive theory (for humans) and another with an associative theory (for monkeys). On this point, Smith is unlikely to get disagreement. But his characterization of the role of Morgan's canon in this case is misguided. Adherents of Morgan's canon would not condone unqualified divergent explanations of the same findings. Instead, such results should prompt a reevaluation of the problem under exploration and the methods used in its investigation. In the case of Smith's work (Smith, Shields, Schull, & Washburn, 1997),

human participants were trained to judge whether a display was dense or sparse, and they were given the option of an escape response which avoided the negative consequences of an incorrect response. When given the same stimuli after a training regime, two rhesus monkeys made the same response pattern as did the humans. Human participants retrospectively interpreted their own use of the escape response as having made uncertainty judgements. We do not know that the monkeys interpreted the task in the same way (they could be interpreting the escape response as a means of reacting to a sample with an intermediate value between dense and sparse), nor do we know that the retrospective claims of uncertainty accurately characterize how the human subjects were actually deciding what response to make. One explanation for Smith's results is that the human and macaque participants are actually undergoing the same associative processes to *produce* the same response patterns, but the humans are retrospectively *interpreting* their own behavior in metacognitive terms.

The Reinterpretation Hypothesis

The term "folk psychology" refers to the naïve understanding people develop about the content of other people's minds (Bruner, 1990; Goldman, 1993; Povinelli, Zebouni, & Prince, 1996). This understanding aids us in making predictions about what another person will do in a given situation so we may behave appropriately. Human folk psychology is such that actions are automatically interpreted in terms of intentions, which are the beliefs and desires motivating outward behavior (Povinelli, 1996). Povinelli and his colleagues developed the "reinterpretation hypothesis" to explain the subtle sociobehavioral differences between humans who make intentional attributions and chimpanzees who presumably do not (Povinelli, 2000; Povinelli, 2001; Povinelli & Giambone, 2001; Povinelli & Vonk, 2003).

The reinterpretation hypothesis recognizes that all social species have evolved psychological systems for predicting the behavior of others. Like all evolved systems, there are ancestral components that are shared with other species, and there are derived components which are unique to a particular group. Human social cognition is specialized to include representations of the probable contents of other's minds. According to the reinterpretation hypothesis, the common ancestors of humans and apes shared a set of complex social behaviors and a system for anticipating the behavior of others, much like those shared by modern humans and apes (Gomez, Sarria, & Tamarit, 1994; Heyes, 1998; Premack, 1988; Tomasello & Call, 1997). The entire ancestral suite of complex social behavior patterns and the psychological mechanisms producing them remained unchanged after the relatively recent evolution of the intention attribution system in the human ancestor. The new system, perhaps evolving under a mechanism of "ontogenetic construction" (Heyes, 2003), allowed the reinterpretation of existing behavior, observed of others and one's self, in intentional terms. This reinterpretation of behaviors could then be used to guide the behavior of the observer. The observer would not necessarily be engaged in new behaviors as a result of the acquired intention attribution system, but the context and frequency of her behaviors may be changed in response to the new intentional interpretation. The observer would also learn to predict and manipulate others' behaviors much more rapidly and more flexibly than if

she had to learn associations from statistical invariance in behavior for each situation observed (Povinelli & Giambrone, 2001). As an example, consider the hypothetical situation of a child whining while reaching for a particular toy. If the mother can encode that the child *wants* the toy, not only can she more quickly act to alleviate the whining on later occasions, but she can also use the toy as a tool to manipulate the child's behavior in the future by offering it as a reward or removing it as a punishment.

The reinterpretation hypothesis emphasizes the importance of Morgan's canon in comparative psychology. Folk psychological understanding is automatic and is shaped by both ancestral mechanisms shared with other primate species and specialized mechanisms. Human folk psychology evolved under pressure to predict the behavior of others, not to represent the underlying psychological causes producing those behaviors. There is no guarantee that the way others' intentions are interpreted is a reflection of reality. Nor can we be assured that our interpretation of our own behavior is a reflection of the true causal forces at work. What the intention attribution system produces are interpretations that are good enough to inform our response behaviors.

There are two theoretical premises that must be established if the reinterpretation hypothesis is to be accepted. The first is the contention that perceptions and intuition may not reflect reality. The second is the existence of, within each individual, integrated psychological systems with separate evolutionary histories, allowing species with different sets of underlying psychological systems to produce similar behavior (Povinelli, 2000; Povinelli, 2001; Povinelli & Giambrone, 2001; Povinelli & Vonk, 2003).

Perceptual Interpretation and Distortion

Perception is a result of the interpretation of sensations received by the brain, producing constructions composed from parallel channels of sensory input (Kandel, Schwartz, & Jessell, 1995). In cases in which perceptual parameters are continuous, discrete divisions are made and interpreted as categories, a process called categorical perception (Goldstone, 1994; Harnad, 1987). Examples of categorical perception are the way the visible light spectrum is defined into color bands (Fanklin & Davies, 2004; Harnad, 2003), or the way timing of voice onset distinguishes linguistic phonemes (Lasky, Sydal-Lasky, & Klein, 1975). Perception is often the output of some higher-order interpretation, rather than a report of what is out there in the world to be observed (i.e., Biederman, 1990). Perceptual distortions occur when the mind is tricked into making incorrect interpretations. Some familiar bottom-up perceptual distortions include simultaneous color contrast, when a hue appears different depending on adjacent colors (Brown & MacLeod, 1997), and other visual illusions (e.g., the Ponzo illusion; Robinson, 1998). Top-down conceptual processes, as well as bottom-up processes, can affect perception (e.g., Ferraro, 1997; Kruger, 1992; Pilling, Wiggett, Ozgen, & Davies, 2003).

Not only is perception mediated by top-down cognitive processes, interpretation is automatic and is neither under the control of the perceiver nor within conscious knowledge (Nisbett, 1977). Intention attribution by the human folk psychology system is simply another case of interpretive perception. A person responds differently to a slap depending on whether it is interpreted as being done in

malice, in jest, or by accident. The attribution of intention is so pervasive that it may be forgotten that it is possible to characterize and respond to behavior without it, and that interpretations of intention may be distorted.

Integrated Hierarchical Systems

According to the reinterpretation hypothesis, the folk psychology system responsible for behavior prediction in humans is made up of separate but integrated components, some of which are possessed by closely related species, and some of which are human specializations. This architecture is not unusual for complex evolved systems; there are many cases of integrated hierarchical systems with separate evolutionary histories. One example is the motor system, with reflex actions being mediated by, but not depending on, signals from the motor cortex (Lee, Cotterill-Jones, & Eccles, 2002; Scott, Mason, & Cadden, 2002). The visual system provides a clearer example of separately evolving, yet integrated systems, with multiple levels of representation that can be integrated or used alone in visual perception (Ahissar & Hochstein, 2004). Hierarchical systems evolution is not limited to cognitive systems. A more easily illustrated example of hierarchical systemic integration can be found in the respiratory physiology of diving marine mammals. There are two distinct respiratory systems found in these animals: The aerobic system functions for shallow dives and the anaerobic system functions for deep dives (Costa & Sinervo, 2004). The evolution of an anaerobic dive mechanism did not replace the aerobic dive mechanism shared by mammals not adapted to long periods without access to oxygen. Both diving mechanisms coexist in adapted mammals such that the specialized diving system is used only when the ancestral system will not suffice.

When a system adapts through the evolution of a new component, the components integrate instead of the new system taking over the function of the ancestral system. When species diverge and one evolves a new system and the other does not, their behavior may be similar except in the special cases where the new system makes a necessary contribution. As in physiological systems, the component cognitive systems contributing to behavior prediction are integrated with derived systems depending on ancestral systems. Where the ancestral systems evolve and develop in the absence of systems derived in related species, a functional representation may produce behavior outwardly indistinguishable from behavior based on a representation built with more contributing systems (Eddy, Gallup, & Povinelli, 1996; Gallup, 1970; Hare, Call, Agnetta, & Tomasello, 2000; Hare, Call, & Tomasello, 2001; Povinelli, 1987; Povinelli, Nelson, & Boysen, 1990; Povinelli & Vonk, 2003; Premack & Woodruff, 1978; Reaux et al., 1999; Whiten, 1996). In the case of social cognition, it is likely that the same ancestral system *produces* social behavior in humans and other primate species, but observed behaviors are *interpreted* by different systems, with humans primarily using the specialized intention attribution system to make these interpretations.

De Waal (1991, p. 302) claims that one of the primary goals of the study of primate social cognition is the “determination of the precise psychological and mental mechanisms underlying the complex sociality of nonhuman primates.” Yet he urges that human social cognitive machinery be allowed to distort conclusions, arguing that scientists should not fight the natural inclination to organize observed

behaviors into interpreted descriptions of intentional behaviors. However, if humans do involuntarily interpret behavior in intentional terms, as de Waal and Povinelli agree, then there certainly is a need in comparative psychology for the guidelines laid out by Morgan. Human folk psychology evolved to predict and react to the behavior of other humans, not to provide humans with a true representation of the mental systems underlying those behaviors. The canon serves to balance the natural human tendency to interpret observed behavior in terms of complex psychological processes, helping to maintain scientific validity in the interpretation of behavior. To this end, the canon is necessarily restrictive. The human intention attribution system may be well-suited, and perhaps accurate, for predicting and explaining human behavior; however, comparative psychologists dealing with nonhuman species must be careful in the application of intuitions about the causes of animal behavior and the content of animal minds.

Application of Morgan's Canon

What chimpanzees understand about other minds has been a focus of research and debate ever since Premack and Woodruff (1978) initiated empirical exploration of the question of chimpanzee "theory of mind." In their ground-breaking study, a chimpanzee was shown a video of a person failing to perform a task and then asked to choose among photographs, one of which depicted an act that would result in the successful completion of the task. The rationale of the study was as follows: If the chimpanzee understood what the person intended to do, then she should choose the correct picture. She did choose the correct picture at above-chance levels; however, flaws in the experimental design do not limit interpretation to a positive demonstration of theory of mind. There are questions as to whether the chimpanzee understood the video clips as problems to be solved, and concerns that an associative strategy could have been used to match scenes characteristics and associated objects (Heyes, 1998; Savage-Rumbaugh, Rumbaugh, & Boysen, 1978; Whiten & Perner, 1991).

This Morgan-esque criticism led to an explosion in the study of chimpanzee social cognition. Other experiments have asked chimpanzees to reverse roles (Povinelli, Nelson, & Boysen, 1992), take the visual perspective of others (Hare et al., 2000; Hirata & Matsuzawa, 2001; Karin-D'Arcy & Povinelli, 2002), and anticipate belief-based behavior (Call, Hare, & Carpenter, 2004; Call & Tomasello, 1999; Povinelli et al., 1990). Experimental results have been mixed, so much so that a leading research group has changed their position on the issue of whether or not chimpanzees have demonstrated theory of mind capabilities. Tomasello and his colleagues stated that nonhuman primates "have learned certain behavioral and contextual cues that may be used to predict the impending actions of conspecifics" (Tomasello & Call, 1997, p. 384), but did not possess an intentional understanding of others, citing lack of evidence to the contrary to support their position. More recently, the same researchers (Tomasello, Call, & Hare, 2003a, p. 153) argue that "at least some nonhuman primates...do understand at least some psychological states in others." Specifically, Tomasello attributes to chimpanzees understanding of seeing and intention. Does recent evidence warrant such a change in conclusion? Others remain skeptical (Karin-D'Arcy & Povinelli, 2002; Povinelli & Vonk, 2004). The evidence does support the conclusion that chimpanzees have a

sophisticated system for predicting the behaviors of others and use that information to shape their own behavior. However, the evidence does not imply that chimpanzees interpret behaviors in intentional terms. The interpretation of experimental results regarding chimpanzees' understanding of others' minds is an excellent test case for Morgan's canon.

Following the advice of Morgan, let us approach the analysis of chimpanzee "theory of mind" research by assessing the systems and mechanisms at work in *human* social cognition. We may use a theoretical model, based on the reinterpretation hypothesis, that includes two hierarchical systems. Since neuroscientists have not yet provided physical evidence of how social cognition processes work, the model is composed of hypothetical constructs (MacCorquodale & Meehl, 1948). According to the reinterpretation hypothesis, all social animals are equipped with an ancestral behavior analysis system (Povinelli & Vonk, 2004). This system detects statistical regularities in behavior, including those of intentional behavior, and uses them to anticipate the actions of others and to plan the animal's own actions. A specialized system, the intention attribution system, then interprets behavioral regularities in terms of intentional states and allows an individual to understand the probable mental states of others and to modify behavior accordingly (Baldwin & Baird, 2001). The intention attribution system is built upon and interacts with the ancestral behavioral representation system, deriving its input from the ancestral system (Figure 1). Yet, each of these systems has a separate evolutionary history, growing out of and intertwining with the other system during development. There are several theoretical accounts of the systems underlying social cognition which fit into this characterization; for example representation of overt (outwardly perceivable) versus covert (unobservable) mental states (Gomez, 1996), or representation of perceptual, motivational, and informational mental states (Premack & Dasser, 1991).

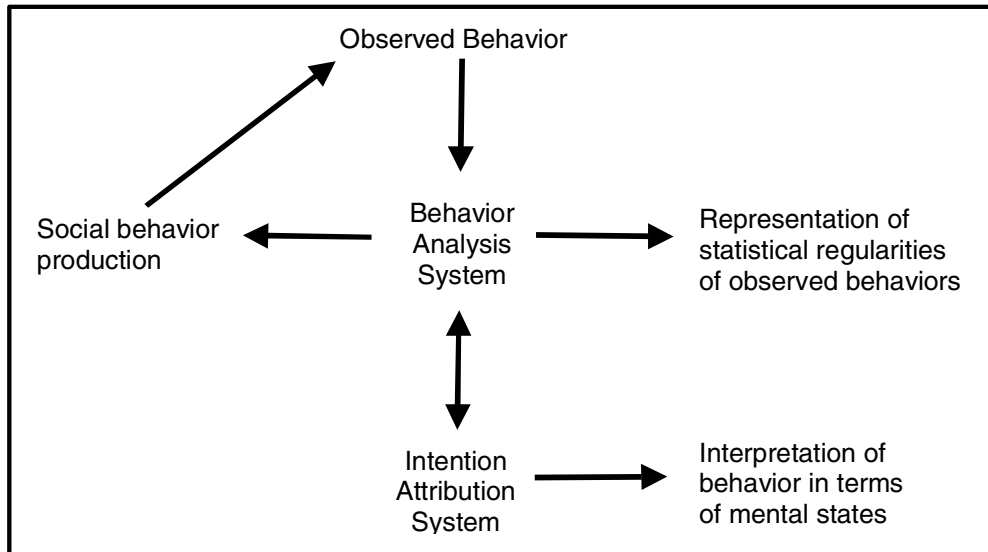


Figure 1. Hierarchical systems for behavior representation.

This brings back the application of Morgan's canon to the question of chimpanzee theory of mind. Are chimpanzees equipped with a system for attributing mental states to other individuals, or do they predict the behavior of others based solely on a behavior analysis system, without the use of an intention attribution system? After identifying the component systems of human behavior prediction, Morgan would suggest to examine the behavioral evidence from chimpanzees to determine which of those human components are functioning in that species.

One basic component of understanding other minds is understanding the psychological state of seeing. This question has been addressed in a series of experiments using a food begging choice paradigm (Povinelli & Eddy, 1996; Reaux et al., 1999). The basic format of this test for visual perspective taking involves a chimpanzee using the begging gesture to request food from one of two experimenters—one who can see her (i.e., experimenter has a blindfold over his mouth) and one who cannot (i.e., experimenter has a blindfold over his eyes). If the subject can take the perspective of the experimenters, it is expected that she will choose the experimenter with his eyes uncovered. The question being addressed is this: Does the chimpanzee understand that one person can see her and the other cannot?

In order to interpret the results of this experiment, a psychological model is developed in the form of a decision rule: "Gesture to the person whose eyes are showing <because he can see>" (Povinelli & Vonk, 2004). The first part of this decision rule can be generated based solely on the analysis of behaviors. The subject knows from past experience that she is responded to more consistently by individuals whose eyes are showing. The second part of this decision rule is based on the attribution of mental states to the experimenters, specifically that they can or cannot see. In a critical test of the chimpanzees' understanding, the subject was presented with an experimenter with his back forward and head turned so his open eyes faced the subject, and the other was seated facing forward, but with his eyes closed. The chimpanzees responded to the basic body orientation of the experimenters, gesturing preferentially to the one whose chest faced forward but with eyes closed, rather than the one looking over the shoulder with eyes open (Reaux et al., 1999). This suggests that chimpanzees do not make attributions of seeing and instead use a behavioral rule to choose an experimenter from which to beg.

Even if the chimpanzees had reliably begged from the experimenter who could see them, the experimental design does not allow a distinction to be drawn between the psychological models including and excluding the intention attribution system (Heyes, 1998; Povinelli & Vonk, 2004). How would the chimpanzee's response differ if her decision rule included consideration of only the visibility of the eyes, and nothing about seeing? It would not. The same behavior would be expected whether or not chimpanzees form an intentional understanding of the experimenters from whom they request food. This is true for every permutation of this paradigm (Povinelli & Eddy, 1996), and would be true whether chimpanzees are behaving toward human experimenters or other chimpanzees. It was this realization, that the theoretical imposition of an intention attribution system is impotent in the psychological model of this social cognition test, that prompted the generation of the reinterpretation hypothesis by Povinelli and his colleagues.

Recent evidence for chimpanzee theory of mind comes from an experimental paradigm designed by Hare and his colleagues (Hare, 2001; Hare et al., 2000, 2001) that purports to show that chimpanzees can use visual perspective tak-

ing to learn what another chimpanzee sees and knows in a competitive context. Although the critical results of some of these studies have failed to be replicated (Karin-D'Arcy & Povinelli, 2002), the ensuing debate (Povinelli & Vonk, 2004; Tomasello et al., 2003a; Tomasello, Call, & Hare, 2003b) has come down to a question of what underlying systems are necessary to explain the behavior of chimpanzees in this experimental paradigm.

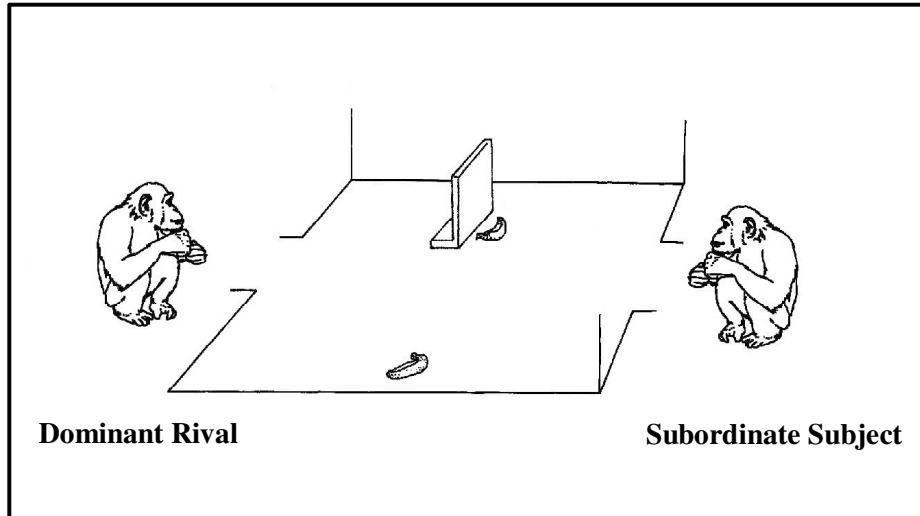


Figure 2. General food competition experimental paradigm. (Drawing used with permission of the Cognitive Evolution Group, University of Louisiana at Lafayette.)

The basic version of the experimental paradigm sets two familiar chimpanzees of unequal dominance status facing each other across a room. In the room are two pieces of food, both visible to the subordinate chimpanzee that serves as the subject. From the perspective of the dominant rival, only one piece of food is visible, the other being hidden behind a barrier (Figure 2). The question posed is whether the subordinate subject can take the visual perspective of her rival and choose to take the food hidden to that rival, instead of the one in the open, to avoid social repercussion. If the subordinate subject were to reliably choose the hidden food, what would that mean? A human in this situation could follow a simple rule, generated by his integrated hierarchical behavior anticipation system: “Don’t go after the food if the rival has oriented towards it <because he has seen it, and therefore knows where it is>” (Povinelli & Vonk, 2003). The first part of this decision rule can be generated based solely on the analysis of behaviors. The subject knows from past experience with dominant rivals that once the dominant has oriented toward a prize, there are negative consequences for attempting to retrieve it for herself.

The second part of this decision rule is based on the attribution of the mental states of seeing and knowing, or perhaps simply wanting, to the dominant rival. The same interpretation problems befall this experimental paradigm as for the food-begging paradigm. The subject’s choice of food generated through the use of an intention attribution system would not differ from that produced by the ancestral behavior analysis system alone. Additionally, there is an alternative hypothesis

(subordinates tend to feed at the periphery when around dominants) having nothing to do with behavior interpretation, which equally well predicts subjects' food choice (Karin-D'Arcy & Povinelli, 2002; but see Hare et al., 2001). Unlike the food-begging paradigm for which the experimental evidence allows us to infer the sole use of behavioral rules, such a conclusion about the underpinnings of behavior in the food competition paradigm cannot be drawn. When Morgan's canon is applied to this experimental paradigm, it becomes evident that this test does not allow one to determine what set of systems underlie the apparent behavior prediction by the subordinate chimpanzee. This exposes a core theoretical weakness of the experimental paradigm and discourages the drawing of an unsubstantiated conclusion about the nature of chimpanzee theory of mind.

Paradigms such as this one, requiring subjects to choose between two social cues distinguished by observable features, cannot provide positive evidence of visual perspective taking. Choice paradigms have been used extensively to test whether chimpanzees are sensitive to the mental states of people and other chimpanzees, and all have the same essential problem. While there is abundant evidence of sensitivity to intentional behaviors in a wide range of species (Agnetta, Hare, & Tomasello, 2000; Hare, Addessi, & Call, 2003; Hare & Tomasello, 1999; Kaminski, Riedel, Call, & Tomasello, 2005; Kuroshima, Fujita, Adachi, Iwata, & Fuyuki, 2003; McKinley & Sambrook, 2000; Miklósi, Polgárdi, & Csányi, 1998; Pack & Herman, 2004; Premack & Woodruff, 1978; Soproni, Miklósi, Topál, & Csányi, 2001, 2002; Theall & Povinelli, 1999; Xitco, Gory, & Kuczaj, 2004), the natural and involuntary inclination of human observers toward intentional attribution does not allow one to determine whether this system of interpretation and representation exists in other species using these approaches.

Through the use of Morgan's guidelines which encourage an understanding of the psychological mechanisms underpinning human behavior, it is determined that this experimental paradigm cannot answer the question posed to it. The inconclusive nature of this experimental paradigm and others entice some to rely on intuition to resolve the questions posed. Morgan's teachings help prevent the drawing of unfounded conclusions based on possible intuitive distortions. Furthermore, proactive use of the canon can help to identify theoretical weaknesses in experimental plans, thus encouraging more rigorous studies. This is especially important in a field such as primate cognition, where experimental resources, and thus attempts at replication, are limited.

This leaves some hard questions. First, if behavioral evidence is not sufficient for the attribution of an intention attribution system to chimpanzees, then how can researchers attribute intention based on human behavior? Second, how can the evolutionary processes and pressures, as those presumably shared by human and chimpanzee ancestors, result in different underlying systems producing the same behaviors?

To address the question of attributing intentional understanding to humans, the short answer is that there is additional evidence, beyond what is available for chimpanzees, to support this contention. In addition to better performance by human subjects on tests of theory of mind (Call & Tomasello, 1999; Gomez, 1996; Povinelli, Bierschwale, & Cech, 1999), humans provide introspective reports of beliefs about others' mental states. Whether true or distorted, humans do represent intentional states. "But," one may argue, "chimpanzees cannot provide this kind of

evidence.” This is true, therefore it is not possible to conclude one way or the other on the question of chimpanzee theory of mind, at least with the tools currently in use.

The question of how humans and chimpanzees, which are so closely related, could have evolved divergent mental systems for subserving the same behavior may be addressed in two different ways. Ryan, Phelps, and Rand (2001) studied just this kind of phenomenon using a computational model of the evolution of species call discrimination. They show that the same discrimination can come to be made by different populations based on different cues when multiple cues are available. In their simulation, call discrimination was based on either call frequency or call duration information. Which system was ultimately tuned by evolutionary processes depended on which system the ancestral population relied upon to make the discrimination, with initial reliance on either system resulting in successful tuning. Applying this to the case of the evolution of behavior prediction, it may be the case that the human lineage fine-tuned the intention attribution system while the chimpanzee lineage fine-tuned behavior analysis. Morgan anticipated problems interpreting studies which attempted to differentiate behaviors generated from closely related systems. When looking at two systems doing the same job, if the mechanisms are slightly different, the nature of the difference will be very hard to determine (Morgan, 1903).

The second explanation for human and chimpanzee divergence is given by the reinterpretation hypothesis, discussed in detail here and elsewhere (Povinelli, 2000; Povinelli, 2001; Povinelli & Giambrone, 2001, Povinelli, & Vonk, 2003). According to this model, the production of social behavior may be mediated by the ancestral behavior analysis system in both species. Therefore, humans and chimpanzees behave similarly because the same underlying psychological system is producing the behavior in both species. However, chimpanzee interpretation of social behavior may be mediated by the same ancestral system that *produces* behavior, while for humans the derived intention attribution system is the dominant *interpreter* of social behavior. This scenario answers de Waal’s concern noted earlier, that “we [must otherwise] assume the evolution of divergent processes for the production of similar behavior” (de Waal, 1991, p. 298). By this model, it is not necessary to assume divergent processes in the production of behavior, only in the interpretation of behavior.

So it is possible that humans and chimpanzees have evolved different mechanisms for social interaction that produce behavior patterns indistinguishable to an observer. Over a quarter century of experimentation and debate leave the question open. Perhaps it is this long wait for an answer that prompts some to point to Morgan’s canon as too restrictive on the progress of comparative psychology.

Canon Cautions

Claims of the continued utility of Morgan’s canon should not be interpreted as universal support of Morgan’s teachings. While the advice intended to temper mental attribution-making is relevant and still important in modern comparative psychology, there are theoretical problems present in Morgan’s canon. The reliance on an introspective induction process to identify cognitive systems at work in humans is subject to the same criticism as is its use by the analogy argu-

ment. However, Morgan uses introspection more carefully than does the argument by analogy. Instead of basing behavioral interpretation on introspection, introspection is used as a tool for generating hypotheses about behaviors (Morgan, 1903). The final interpretation of behavior should be based on experiments that carefully discriminate between the possibilities generated through introspection.

Morgan's canon is also anthropocentric. Morgan begins with the assumption that all animals have a subset of human cognitive capabilities. The notion of a psychological scale, whereby one species is more cognitively evolved than another, is itself problematic. The assumption of a process of terminal addition in the evolution of cognitive abilities has generated important work in comparative psychology (i.e., Antinucci, 1989; Parker & McKinney, 1999); however, it would be unwise to assume that there has not been cognitive divergence, even among closely related species. All extant species have been evolving for an equal amount of time and each may have cognitive specializations. In light of this, it is not surprising that attempts at modernizing the canon by defining a cognitive hierarchy have met with little enthusiasm (Thomas, 1998). An alternative approach to the modernization of Morgan's canon is to replace the notion of a psychological scale with the concepts of ancestral and derived psychological processes. Use of the terminology "common" and "specialized" as alternatives to "lower/simple" and "higher/complex" brings discussion of Morgan's teachings more in line with modern evolutionary theory (Sober, 1998).

While some of the flaws of the argument by analogy are shared by Morgan's canon, the canon acknowledges them and encourages careful interpretation of animal behavior because of them. The argument by analogy instead embraces both anthropocentrism and introspection as tools for making mental attributions to nonhuman animals. Acknowledgement of these weaknesses does not turn researchers from the rest of Morgan's advice. Instead, these weaknesses stand as even greater reason to reject analogy as a criterion for the attribution mental states and hold to the more restrictive standards provided by Morgan.

Given the imperfections of Morgan's canon, should comparative psychologists develop a new alternative attribution criterion? Given the continued reliance on the application of an understanding of human psychology toward the study of nonhuman psychology, and the absence of an alternative frame of reference, comparative psychologists are bound to some degree of anthropocentrism.

Conclusion

Many comparative psychologists appreciate the role of Morgan's guidance in the establishment of their scientific field, but believe that the constraints he put in place are no longer necessary. To the contrary, comparative psychologists must continue honing their methodological and inferential techniques. There are more people today than ever before involved in comparative psychology research, with little emphasis on experimental replication. This allows greater opportunity for human error and misjudgment. Additionally, comparative psychology research is disseminated through the popular press, raising public interest and sparking social issues, thus attracting pressure from people and organizations less trained in analytical reasoning. This is especially true in ape-human comparative research. Sci-

entists must remain committed to scientific and logical principles in the face of social pressures.

There is much at stake. Failure to check the human tendency to view all animals' behavior in terms of human cognition can lead to loss of sight of one of the most important features of the study of human cognition: human's evolutionary heritage as mammals and as primates. The kind of analysis encouraged by adherence to Morgan's canon allows one to place human specializations in context and to gain greater understanding of the evolution of the human mind. It also allows one to be receptive to nonhuman cognitive specializations. All extant species have evolutionary histories as long as that of humans, and each may have specializations as interesting as those produced by human history. Comparative psychology has a critical role to play in the study of normal and abnormal human cognitive development, as well (Gomez et al., 1994; Yonas, 2001). Maintaining emphasis of the subtle cognitive differences between humans and apes will serve to enhance an understanding of alternatives to "ANTCOG" (adult, normal, typical cognition; von Eckardt, 1993), thus indirectly benefiting a wider range of psychological issues, including studies of infant humans and abnormal development.

Is Morgan's canon too restrictive of the progress of comparative psychology? No. Nothing in this guideline limits the observations made, nor the questions generated. Where scientists are restricted is in reflexively drawing conclusions based on human psychological programming. The consideration of phylogenetically common processes that may be at work allows a reevaluation of experimental tasks to determine whether they are valid tests of the phenomena of interest. Adherence to the canon forces one to dig deeper when designing experiments and devising theories, and, in doing so, Morgan's canon pressures comparative psychologists to produce better science.

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Received April 8, 2005.
Revision received July 26, 2005.
Accepted August 1, 2005.