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The Cognitive Animal

Empirical and Theoretical Perspectives on Animal Cognition

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As I was preparing to leave school for university, I recall expressing an interest in studying the mind; psychology perhaps, or even philosophy. This was an idea that clearly troubled my teachers. I think it was my biology teacher who announced that all psychologists were themselves pretty loony, so I would do much better to get a solid scientific foundation in a biological subject like zoology, then decide what to do next. And that is what I did, with the perhaps inevitable final intellectual destination of the sciences of the mind. Although I think my biology teacher was wrong about psychologists (well, mostly!), following his advice had the wonderful benefit that by the time I came to study the mind I was fully steeped in the principles of evolutionary biology.

Of the many likely consequences of this decision, I should highlight two here. One is the working hypothesis guiding my research—that the mind will only be understood as a biological adaptation, shaped by evolutionary processes to deal with a certain set of ecological challenges and opportunities. Second, intimately linked to this hypothesis is the methodological principle that a research program will yield important insights only if it is grounded in the animal’s behavior in its natural habitat.

This perspective was greatly shaped by Lorenz, Tinbergen, and von Frisch, whose groundbreaking work led them to the 1973 Nobel Prize. Always building on a foundation of good natural history, they used a great variety of complementary methods, including systematic and quantitative observation, and experimentation in both field and laboratory. This combination was enormously productive and, given the way it was grounded in nature, achieved insights that no other approach could.

In contrast, turning to my own discipline, it seems all too easy to classify many contemporary primatologists as *either* field researchers *or* laboratory workers; as *either* observers *or* experimenters. Among the notable exceptions, who

could be seen as emulating the catholic yet integrated methodological programs of Tinbergen and company, are such figures as Kummer, Matsuzawa, Cheney, and Seyfarth.

In this essay I illustrate our own efforts to this end in relation to research on social learning and culture. However, this is but one component of a larger topic we are studying, which is beyond the scope of this brief essay and therefore is sketched only in outline here. Its scope is essentially the “social mind.” The Machiavellian intelligence hypothesis is that the intelligence of monkeys and apes is an adaptation, not so much to the challenges of the physical world (like finding food), as to the problems encountered in negotiating a particularly complex, natural, social world (see Byrne and Whiten 1988, including the foundational articles of Humphrey 1976, and others; Whiten 1999, 2000a; Whiten and Byrne 1997). This hypothesis has come to be supported by a series of studies that find measures of encephalization to be more closely related to indices of social complexity than to those concerning activities like finding food (Barton and Dunbar 1997).

Examples of our efforts to elucidate components of this social complexity include work on tactical deception (Whiten and Byrne 1988), management of conflict and reconciliation (Castles and Whiten 1998), and “mind reading” (or a “theory of mind”; Whiten 1998a, 2000b). This research reveals primate minds to be populated with a variety of sophisticated cognitive mechanisms that deal with a diversity of specifically social and complex problems in their daily lives. Learning from others (social learning) is a further aspect of this elaborate social mind. It is a phenomenon appropriately included in the scope of Machiavellian intelligence insofar as it is yet another way in which an animal can exploit to its benefit important information unique to its social environment.

Social Learning and Culture

Baboons survive in habitats that are not conducive to most other primates by exploiting a great diversity of food types that can be difficult to find and/or process (Whiten et al. 1991). For example, adult olive baboons (*Papio anubis*) I studied in Kenya in the late 1980s would yank up clumps of a large sedge, *Mariscus*, and deftly extract the small edible parts through a hierarchically organized sequence of actions (Whiten 1988). The clump would be held in one hand while the other hand grasped a tuft of stems, quickly twisting it around to detach it and bring it to the mouth to bite off (and spit out) the sheath; then the white, nutritious stem base was revealed and could be bitten off; the next tuft was twisted off and the process was repeated, until all the tufts were dealt with. Juveniles did not use this structured technique, but did observe their elders doing it and later came to use it themselves. So is this an example of social learning?

In the field, it seems difficult, perhaps impossible, to tell whether it is. Primates develop slowly. Behavior like the slick, adult style of *Mariscus* processing typically emerges over periods of weeks or months. There seems to be no way to discriminate between the roles of individual and social learning, let alone to differentiate between alternative social learning processes. For example, maybe the juveniles learn by copying the method from their elders (imitation); or perhaps their attention is merely drawn to the sedge (stimulus enhancement) and they work out the optimal way to eat it through trial and error. Typically, in the field, an ethologist sees the focal subjects only at intervals, between which all kinds of experience may be shaping them in ways the scientist cannot see.

I therefore decided that to study the social learning process, and particularly to probe underlying cognitive processes, an experimental approach would be necessary, although of course it should be designed to incorporate the kinds of

problems observed in the field. The result was what Debbie Custance and I called an “artificial fruit”; an object with an edible core that, like *Mariscus*, requires a series of manipulations to remove or disable inedible components or “defenses” (figure 47.1). The specific design of our first fruit had two important aspects to it. First, each of three different kinds of defense could be removed using one of two alternative methods; for example, twisting and pulling out a pair of sticks wedging the fruit closed, or poking them through. This meant that in the experiment, two samples of subjects would each see only one of the two alternatives, and we could then assess the extent to which the difference was copied into the subjects’ own subsequent actions. The other aim of the design was to mimic aspects of complex natural foraging like *Mariscus* eating; accordingly, the fruit had several different kinds of defense that had to be dealt with sequentially, and repetitions or cycles of actions were also built in. Note that this was not a tool-using task. Most primates are not in fact great tool users and we wanted to present tasks more like those that all primates perform, to permit a program of comparative studies.

As things turned out, the first subjects that became available for these studies were young chimpanzees (Whiten et al. 1996), not baboons. In addition to the chimpanzees, we tested young children because research on imitation inevitably begs for comparison with a species (our own) that is assumed to be strongly imitative (“*Homo imitans*”; Meltzoff 1988). We found that the children conformed to this expectation and typically produced high-fidelity copies of the particular actions they had seen used. The chimpanzees’ response was more likely to be a rougher, more selective copy of the action they witnessed. They were more ready to ignore what a model did if they themselves could see a way to take a shortcut. However, to varying extents the chimpanzees did incorporate various aspects of the behavior they had seen, such as twisting the wedged sticks;



A



B

Figure 47.1

(A) Working with “artificial fruit.” A juvenile chimpanzee attempts to open an artificial fruit by pulling and twisting out a pair of bolts that jam the top shut. The subjects in an experiment will have seen the bolts either pulled out or poked through, so their imitative tendency can later be measured. Also holding the top shut is a handle that can be either turned or pulled up to release it; this is held in place by a pin that must be removed first by another pair of alternative actions. (B) Recording chimpanzee attempts on a “fruit.” A young chimpanzee on Ngamba island, Uganda, is busy opening an artificial fruit and already has both bolts removed.

this was not actually necessary to remove the sticks and so reinforces our conclusion that our naturalistic experiment showed chimpanzees learning to apply a particular technique by imitating what they saw another individual doing.

Other parts of this research program delineate a number of different aspects of the social learning process in chimpanzees, such as the acquisition of information on the sequential structure of actions (Whiten 1998b). They also extend to a number of other species of apes and monkeys, some aspects of which we will return to later in this essay. The above summary, however, is sufficient to illustrate that the basic experimental approach is able to identify social learning in a way that has so far proved impossible for animals in the wild, who slowly and naturally perfect similar kinds of behavior. With this knowledge in mind, let us return to Africa.

Charting the Cultural Variation of Wild Chimpanzees

A few years ago, because of what we discovered through the experimental program, I was invited to write a review that also extended to the topic of culture (or tradition) in primates (Whiten 2000c). In the course of this I tried to establish just how much we knew about cultural variation in the species for which it seems most extensive—chimpanzees. This was both exciting and frustrating: exciting because, as long-term studies have accumulated, chimpanzee researchers have been able to construct larger and larger charts of the putative cultural variation across Africa (McGrew 1992; Boesch 1996); but this literature is a bit frustrating for several reasons. One is simply that this work tends to have been done by aficionados of chimpanzee research, who have not fussed too much with defining types of behavior that are still a little mysterious to the rest of us, so it is not so easy to cross-reference one expert's tables with another's. More important, the collating work has been done on the basis of

published records. This is not too satisfactory because this source is likely to be incomplete in both positive and (just as crucial) negative records at any one site; also, the frequency of a behavior pattern, which is clearly relevant to whether the behavior can be considered cultural, may not have been reported.

I felt a different approach was needed. Together with Christophe Boesch, I approached the research directors of the most long-term field sites and we agreed to proceed systematically through two phases of research. In the first, we drew up a list of behavior categories, published or not, that researchers suspected might be cultural variants. Full descriptions were set down and agreed upon (see Whiten et al. 2001).² With nine international contributors, this process was much more complex than one might guess! It generated the rather extraordinary total of 65 candidate cultural behaviors (a tribute in itself to the inventiveness of chimpanzees). The field directors and their staff then categorized each behavior pattern according to whether it was customary (typical for their site), habitual (less than customary but still consistent with social transmission), merely present, or absent, either with or without an obvious ecological explanation.

Collating all the information, we checked for behavior patterns that met our criteria for cultural variants: those customary or habitual in at least one community, yet absent without ecological explanation in at least one other. In this way we identified no less than 39 cultural variations (Whiten et al. 1999), a figure far exceeding that reported for any other species except our own (indeed, previous studies of traditions among animals have typically identified variation in just a single behavior). Although some behavior patterns occur in more than one community, each community has its own unique suite of variants, so that if we know enough about a chimpanzee, we can locate it geographically on the basis of its cultural repertoire, as we might do for people (Whiten and Boesch 2001) (see figure 47.2).

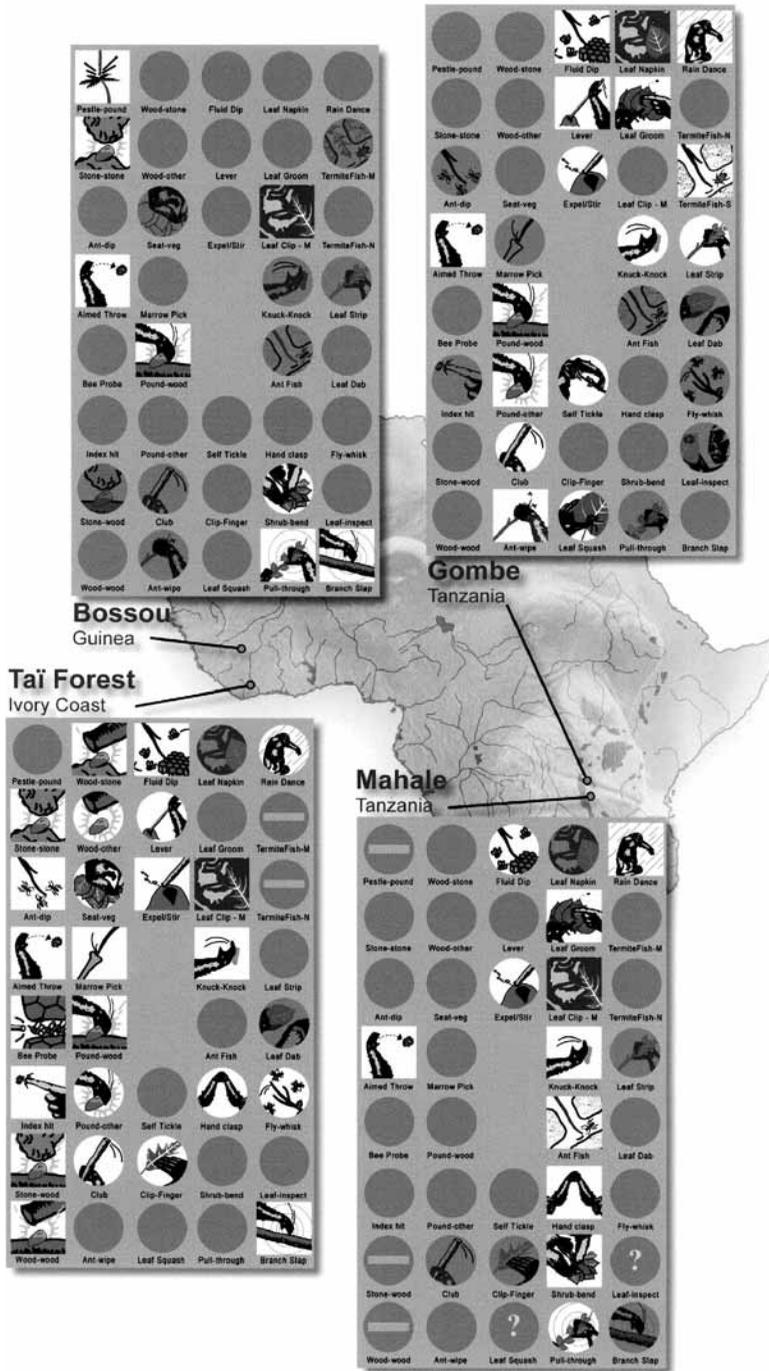


Figure 47.2

Chimpanzee cultures. Variation in behavior patterns of chimpanzees at four long-term study sites. Square, customary; circular, habitual; faded circular, present; blank, absent; bar, ecological reason for absence; question mark, unknown. From an ongoing collaborative project (see Whiten et al. 1999, 2001).

But are the variants really all cultural? Several kinds of information might be thought relevant to judging this, including the background experimental evidence that chimpanzees are social learners (and in some circumstances, imitators); that juveniles devote serious effort to scrutinizing adults performing these behaviors; that ecology is not a plausible explanation (for example, the same materials are available whether the behavior is customary or absent); and similarly, that a genetic difference is not plausible (for example, variation occurs between nearby communities of the same subspecies).

Take the case of ant dipping, which in the Taï Forest preserve in the Ivory Coast involves using a short stick to pick up a few driver ants and transfer them directly to the mouth, but at Gombe in Tanzania involves a much more efficient trick of swiping a hand along a long wand to gain a large ball of ants. Juveniles watch these activities intently; ecological explanations for the different methods seem unlikely since ants and sticks are available at each site; and a genetic cause seems unlikely, for the behavior does not even exist at Mahale, a short distance from Gombe. But note I say “unlikely.” Can we prove the sticks and ants are really similar? Perhaps not. What would really clinch the cultural status of these behaviors is if we moved some chimps from Taï and Mahale to Gombe and they adopted the local technique. Since for ethical reasons this is not likely to happen, the importance of using relevant experiments to complement what the field research appears to be telling us, even if the experiments are not done in the wild, is clear.

Wider Horizons: The Comparative Cognitive Ethology of Social Learning

In this essay I have focused on what we are learning about chimpanzees. However, the two different kinds of method I described have been

developed very much with comparative research in mind. The approach described earlier for the cross-cultural survey could, we hope, be used as a kind of template for other taxa of animals where multiple field studies are accumulating reliable data on the absence of behavior patterns in certain populations. Such data already exist for other primates, but further candidates include the topical cases of capuchins (Fragaszy and Perry, in press) and whales and dolphins, the cultural complexity of which has recently been debated (Rendell and Whitehead in press).

In the case of the experimental approaches, comparative research has already been extended to other primates (e.g., Custance et al. 1999; Stoinski et al. 2001) and nonprimates (e.g., Huber et al., 2001). Here, however, we soon encountered a problem in designing a task that could be used to make valid comparisons. We found, for example, that marmosets were unable to open an appropriately scaled-down version of the artificial fruit, either spontaneously or with a variety of training efforts. A case like this forces us to take a different approach. Accordingly, we created an artificial fruit appropriate to the marmosets' capabilities (Caldwell et al. 1999).

Perhaps this should lead us to explicitly recognize two different comparative approaches, one in which different tasks appropriate to each species are created (facilitating a comparison of social learning that takes account of differences in other underlying abilities) and another in which the same (appropriately scaled) task is given to all species (making for a more direct comparison of what they actually do acquire, whatever the underlying explanation). Probably it will be the complementary application of both these approaches—in conjunction with the very different methods described above—that has the greatest potential for allowing us to obtain an insightful, comparative, cognitive ethology of culture and social learning.

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Notes

1. With due respect to Kummer (1984).
2. The Chimpanzee Cultures Website (<http://chimp.st-and.ac.uk/cultures>) incorporates a searchable, illustrated database covering all the chimpanzee behaviors surveyed and their distribution.

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