

5

A DIACHRONIC MODEL FOR INFORMATION DONATION

A thorough discussion of social information transfer in primates must include modern humans. In keeping with the subjects treated in earlier chapters, my goal in the first part of this chapter is to support the contentions that human adults actively donate information to immatures in a variety of contexts and that human infants are excellent information acquirers who may influence their own socialization (see also King n.d.). From there, I will go on to suggest a framework for assessing social information transfer diachronically—that is, for analyzing changes over time in information acquisition relative to information donation in primates.

Social Information Transfer in Humans

Surprisingly few anthropologists have tested hypotheses to find out if human children acquire certain skills, and the information upon which those skills depend, primarily through information donation or information acquisition. The best clues to this issue come from hints about the training or teaching of children that are scattered throughout ethnographies and articles about child socialization. Anthropologists seem to take teaching in humans for granted, so they fail to study it empirically or they prefer to emphasize more subtle influences on child development, as Whiting and Whiting (1975) do in their classic cross-cultural study.

One anthropological approach to social information transfer in humans would investigate how the information needed to master certain skills was acquired by immatures in a variety of cultures. Attempting to untangle the role of verbal instruction from other types of teaching would be a good place to start.

Perhaps a child must master the skills necessary for digging up underground tubers, an extractive foraging task. Only certain tools made in certain

ways will get this job done efficiently, and only certain tubers found in restricted locations are edible and nutritious. Assuming that social information transfer occurs—rather than simply trial and error without any social interaction—what is its nature? Do adults merely extract their own tubers while tolerating close observation and scrounging of food scraps by immatures? Or do adults guide immatures in their tool choice, tool modification, choice of location in which to search for tubers, or selection of tubers? Is this guidance primarily verbal or nonverbal? If primarily verbal, could the task have been learned in the absence of speech? If primarily nonverbal—that is, accomplished through guidance of motor patterns—could the task have been learned through speech alone? Long-term observations in the child's natural habitat rather than in the laboratory would be most advantageous for answering such questions, but complementing natural observations with controlled experiments in the natural setting would be ideal.

We know that human immatures attain some specific skills through direct training, verbal and otherwise. When considering the training of children, the notion of behavioral routines that are constructed by adults and directed toward immatures comes up repeatedly in the literature on child socialization and language acquisition. Parents among the Kipsigis of Kenya, for example, deliberately and methodically teach their infants to sit and walk: "There were specific behavioral routines, with specific words to refer to them, that parents and siblings all knew and practiced on a nearly daily basis months before the skills were fully acquired by the baby" (Super and Harkness 1986:556).

When focusing on how children acquire language skills, the idea behind the role of behavioral routines is that children learn language in the process of interacting with others in patterned ways (Bruner 1983; Peters and Boggs 1986:80; Tomasello 1992; Savage-Rumbaugh et al. 1993). In the context of verbal exchanges, "an *interactional routine* is a *sequence of exchanges* in which one speaker's utterance, accompanied by appropriate nonverbal behavior, calls forth one of a limited set of responses by one or more other participants" (Peters and Boggs 1986:81, emphasis in original). In reviewing research on language acquisition in children, Parker (1985:618) points out that "mothers provide simple, repetitive stereotyped behavioral routines . . . that elicit, support, and organize the emerging communicative behaviors of their infants. By overestimating their infants' communicative intentions, mothers assign them a real interactional role and 'pull' them along the leading edge of their emerging abilities."

The mutual participation of adults and infants in this process is clear (see Bruner 1983), but the routines and interactions involved need not always be verbal (Bruner 1983; Tomasello 1988). Joint attentional processes may instead

involve manipulating or exploring a toy in repeated and predictable ways. Or the adult may use a combination of verbal and nonverbal markers to highlight the predictability of everyday interactions with the infant:

These routines scaffold the initial language acquisition of the child in the sense that they create, with no need of a conventional language whatsoever, a shared referential context within which the language of the adult makes sense to the prelinguistic child. And even after they have learned some words, children continue to acquire the vast majority of their language inside nonlinguistically understood joint attentional episodes. (Tomasello 1992:70)

Such a shared focus, when developed naturally, can be more effective for a child's language acquisition than the situation in which an adult explicitly directs the child's attention (Tomasello 1988).

Even when anthropologists do not mention behavioral routines, their descriptions of the training of children clearly indicate information donation, even to very young children. Among the Aka Pygmies of Zaire, children as young as 6 to 12 months of age are trained by their parents in subsistence skills involving small knives, axes, and spears (Hewlett 1991a). The amount of correction or punishment of children's behavior varies, of course, across cultures. The old anthropological generalization that adults in nonindustrial cultures are "indulgent" toward children is simplistic (Hewlett 1991b). Direct guidance, including correction and punishment, exists in many behavioral contexts in nonindustrial cultures.

In many societies, children are assigned certain tasks, sometimes according to gender; this kind of task assignment qualifies as a form of information donation because it directly guides immatures' experience and obtaining of knowledge. Extensive information donation exists in the context of feeding. Dettwyler (1989) notes the wide variety of techniques used cross-culturally by parents and other caretakers to control young children's food consumption, including force-feeding, physical punishment, physical restraint during eating, encouragement, feeding games, and rewards.

Judging from comparative data, the imitative ability of human immatures exceeds that of monkey and ape immatures (see Meltzoff 1988; Tomasello 1990; Visalberghi and Fragaszy 1990; Whiten and Ham 1992). Even so, for human children to acquire some knowledge may require (rather than merely benefit from) information donation. What sort of knowledge falls into this category is not known, but Gibson's (1991) distinction between techniques and technology in human tool use and manufacture may indicate where to look.

Technique, a type of procedural knowledge, involves a set of specific

sensorimotor skills and action sequences, whereas technology, a type of declarative knowledge, is far more comprehensive. Technology involves “accumulated knowledge encompassing mathematical and scientific principles as well as information about the geographic, biotic, physical and social environments in which tools are made and used” (Gibson 1991:256). Gibson notes that language may have little influence on technique but profound influence on technology. Whereas techniques *may* be mastered through information acquisition alone (but would benefit greatly from information donation, as do the tool techniques of immature Tai chimpanzees), I suspect that skills related to technology require some kind of guidance, whether mediated through language or not. The logic here is reminiscent of that used earlier when I suggested that knowledge about hominid tool manufacture itself might be gained through information acquisition, but if tools also carry stylistic messages, then immatures would need information donation to master the broader implications of tool design. This argument may be extended to foraging because so much of human foraging is tool aided.

Information donation need not come from parents but may involve older siblings or other older children who have more experience or greater skills. Studying the effect of peer groups (which, despite the name, include children of different ages and experience levels) on child socialization “reverses a long-standing bias in western psychology that overemphasized the role of parents, especially the mother, as socialization agents” (Harkness and Super 1985:219). Within peer groups, gender segregation may not be enforced, but children tend to associate preferentially with members of their own sex, thus influencing their own socialization (Harkness and Super 1985) and acquiring information in a way reminiscent of behavior seen among some primates. These multi-age play groups “assist parents in childcare, help in the transmission of culture, and promote greater intergenerational equality” (Hewlett 1991b:18), and thus may involve information donation.

As a rule, nonindustrial societies exhibit a higher level of multiple caregiving to immatures than is seen in industrialized countries. In a quantitative study of this phenomenon among the Aka Pygmies, Tronick et al. (1987, cited in Hewlett 1991b) found unusually high levels of multiple caretaking: at four months of age, infants spent 60 percent of their time with people other than their mothers and were exchanged among caretakers over eight times per hour. Females other than the infant’s mother often nursed the baby. A great deal of information presumably can be donated by nonparents in this context.

In recent years, interest has increased in the active, skilled human infant, a focus that—just as in the study of other primates—helps to counter the established focus on adults in socialization. This perspective can be applied productively even to the youngest infants. After years of working with neonates, Brazelton (1979:79) comments that “the old model of thinking of the new-

born infant as helpless and ready to be shaped by his environment prevented us from seeing his power as a communicant in the early mother-father-infant-interaction.” Brazelton’s observation helps us envision the infant as capable of flexible behavior that elicits caretaking from adults, but it is hard to know whether or when the very young infant is actively gathering information or attending to parental cues transmitted verbally or nonverbally.

Attending to nonverbal behavior is an important way in which immatures acquire information from adults. Investigators study what is termed *social referencing* in order to explore the way in which immatures make use of adults’ nonverbal cues, including facial expressions. In social referencing, infants use the expressive behavior of others to form their own emotional reactions (Feinman 1985). It may occur with or without solicitation—that is, the child might or might not actively solicit information by expressing some need. Examples of social referencing provide interesting parallels with the behavior of primates. A child may decide how to react to a strange person or object, for example, only after first checking with its mother by decoding her facial expression.

In the study of human social information transfer, then, information donation is known from a variety of behavioral contexts, but the precise relationship between information donation and information acquisition is not well understood. Still, it is evident that humans donate more information to immatures than do other primates. Structured behavioral routines are seen more frequently in humans than in other primates, although such routines may occur in other species as well, since they may be carried out either with or without language (see chapter 6). Like the young of their nearest relatives, human immatures are superb information acquirers, but even so the relative contributions of adults and immatures to information transfer shifts in humans (King n.d.). This result would be unsurprising if information donation were equated with verbal instruction, but it holds true even when, as in this book, no such equation is made. Adults in all human cultures practice guidance, correction, and teaching of immatures’ behavior. The difference between humans and other primates is one of degree.

A Move Beyond Description

The comparison of data on the behavior of extant monkeys and apes with that for extinct hominids has suggested differences among primates in the relative roles played by immatures and adults in acquiring and donating information. Interpretation of patterns in these data can be made along two primary dimensions, phylogeny and behavioral context. Assessing social information transfer according to phylogeny produces a continuum of abilities related to information donation, but variation according to behavioral context appears to be significant as well.

Immature monkeys are adept at acquiring information about social skills, predators, and foraging by initiating and maintaining interactions with adults and by attending to cues made available to them through adult behavior. They receive donations of information from adults only rarely. An exception occurs in the foraging context among callitrichids, the only monkeys that regularly share food. Although skill at information acquisition is not lost in other primates, information donation increases along a continuum from monkeys to apes, hominids, and humans. Among great apes, especially the chimpanzee, information transfer in social skills and predator avoidance does not differ appreciably from that of monkeys. Information donation in foraging and in food sharing both increase, however, a correlation that may go beyond the simple fact that food sharing is a type of information donation; chimpanzees share more food than any other primate except callitrichids and donate more information about foraging in other ways as well. A pattern therefore emerges in the behavioral context of foraging, whereas no pattern is evident for information donation about social skills and predators.

Reconstruction of hominid social skills and predator avoidance is not currently possible, but reconstruction of hominid vocal communication, foraging strategies, and material culture suggests that hominid adults donated more information to immatures than do the adults of any other primates except modern humans. Early hominids—the australopithecines and *Homo habilis*—may have functioned similarly to chimpanzees in terms of foraging-related information donation. Increases in information donation occurred gradually, so that with *Homo erectus* and *Homo sapiens*, more information was donated more efficiently and probably in more contexts as well. The behavior of hominid young is particularly hard to assess, but presumably these immatures were efficient, active information gatherers, as are other primates. Adult donation of information nonetheless increased over time and culminated in the direct guidance and intentional teaching that characterizes modern human behavior.

Understanding why these behavioral changes came about can be undertaken within the framework of diachronic anthropology. Diachronic studies go beyond the description of behavior observed during selected “slices of time” to model change in biocultural systems. One drawback to the diachronic approach used here is that although I attempt to trace behavioral change using an evolutionary perspective and to look at the continuum of behavior across primate species, my method inevitably assumes that behavior observable in the present reflects behavior of the past.

Extant monkeys and apes can be compared to modern humans along a very real, observable behavioral continuum. Once hominids are included, however, the implication is that the behavior of extant monkeys and apes can stand in for the behavior of extinct monkeys and apes to produce a continuum in *time*,

allowing the consideration of why certain behaviors originated, were selected for, and evolved. Problems with this approach are reminiscent of those associated with referential models (see chapter 1). The approach is most valuable when the aim is not to produce a referential model but rather to identify selection pressures that probably operated on past primate behavior and to create hypotheses that can be tested to further understand primate behavior in the present.

Two important points form the core of my diachronic approach. First, chimpanzees donate more information than do monkeys and other apes, although the difference is not one of kind but of degree. Indeed, chimpanzees are not obviously distinct from early hominids in terms of information donation. Second, the clearest pattern for information donation is found in the foraging context and correlates with food sharing and extractive foraging with tools. Because they are based on limited data, these points are better thought of as working hypotheses than as conclusions.

My goal now is to consider whether these two points can be *explained* as well as described using an evolutionary perspective. A few caveats must be offered. First, my focus is not on the evolution of the *capacity* for information donation; some monkeys are capable of it, as we have seen. Instead, the discussion converges on one question: Why is there increased information donation, especially during foraging, in chimpanzees and early hominids as compared to monkeys and other apes? Restricting my framework in this way is preferable to attempting a premature explanation of variation across behavioral contexts. Gaps in the data—for example, in our understanding of referential vocal communication in apes—are too large to permit reasonable speculation about variation across contexts. Moreover, a focus on foraging is particularly amenable to a continuum analysis because reconstructions of hominid foraging behavior are possible.

Second, with this restricted framework I admittedly risk asking the “wrong” questions. If the patterns I identify in the data do not hold up, the diachronic approach pursued here may go off in a direction that will not help anthropologists to understand change. Certainly a host of other questions emphasizing different aspects of behavior could be asked. I intend to suggest only one way in which diachronic anthropology might be applied to the issue of social information transfer.

Ultimate and Proximate Factors

Both ultimate and proximate factors may be important in the expression of increased information donation. Ultimate factors select for or “drive” the evolution of increased information donation. A focus on ultimate factors essentially

asks how and why increased information donation evolved. A focus on proximate factors asks what immediate conditions allowed or encouraged the expression of the capacity for information donation, and it includes consideration of the physiological and cognitive mechanisms of information processing.

Immediately it should be clear that keeping ultimate and proximate factors distinct will be difficult at times. In the section on tool use in chapter 3, for example, some primates, including orangutans and gorillas, were shown to use tools only in captivity. Moving an orangutan from its natural habitat in southeast Asia to the National Zoo in Washington does not, of course, cause the capacity for tool use to appear. Nothing can be learned about the origin of tool use (the ultimate cause) by studying zoo orangutans, whereas much can be learned in the zoo setting about what proximate factors—perhaps leisure time or boredom (see Beck 1980)—encourage the expression of tool use. Primatologists know more about tool use in wild as opposed to captive primates than they do about capacity versus performance in information donation. Might monkeys that show limited information donation but clearly have the capacity for it become consistent information donors under certain circumstances? If so, the increased information donation claimed for chimpanzees would be a matter of proximate “releasers” and not ultimate factors.

Foley (1991:30) makes a distinction between conditions and phenotypic characters that should be maintained when trying to understand behavior:

Conditions constitute the context or selective pressure that prompts or requires complex behaviour. Phenotypic characters are the actual behavioural characteristics that are selected for and come to be incorporated in the behavioural repertoire, resting in the individual and providing it with a reproductive advantage.

In Foley’s terms, then, I want to understand the conditions that led to increased information donation. My primary focus is on ecological conditions that affected foraging in primates. Certain cognitive abilities—phenotypic characters—must underlie increased information donation, and I explore one possible relationship between cognitive changes and information donation. Through a focus on ecology and a brief look at cognition, I examine increased information donation at one particular “shift point” in primate evolution—the shift to increased information donation that occurs in chimpanzees and early hominids as compared to monkeys and other apes. Use of the term *shift point* is not meant to suggest rigid stages of primate behavior. To assume a monkey stage, an ape-and-early-hominid stage, and a later hominid stage of behavior would be to misread seriously the intent of a gradualistic, diachronic approach. In fact, some populations of monkeys may behave in the ways ascribed to apes,

some early hominids may fit better into the description for later hominids, and so on. Nevertheless, discussion of the primate continuum is most valuable, in my view, when it focuses on selected shift points.

Ecology and Cognition at the Shift Point

Ecological factors are all the features of an organism's habitat that affect its behavior, including climate, disease, predators, and food. My focus on food and foraging strategies does not imply that other ecological factors did not play a role in increased information donation. Cognition may be taken to mean the ability to relate previously unrelated pieces of information in novel ways and to apply the results to new problems (Markl 1985). Recent data and interpretations suggest that ecology and cognition may interrelate in significant ways. The cognitive abilities of primates may correlate with certain types of foraging strategies, such as frugivory or, more specifically, searching for fruit that is patchily distributed (Clutton-Brock and Harvey 1980; Milton 1981).

Although it may be possible eventually to treat them in a related way, I consider ecology and cognition separately here. Great apes, for example, may be able to behave in a cognitively more sophisticated way than most monkeys, yet ecological pressures may play a role such that monkeys adapted to certain environments may cognitively outperform most apes. Correlating cognition with phylogeny and ecology is neither original nor highly speculative, although alternative views exist (MacPhail 1987).

The thesis of my diachronic approach is this: a likely selection pressure for greater donation of information is a shift to dependence on foods that require a significant investment by immatures in acquiring foraging skills and the information on which those skills depend. Embedded foods that require extractive foraging with tools provide the best example. Extractive foraging and its significance for primate evolution has been explored in a series of papers by the anthropologists Parker and Gibson, writing together and separately (e.g., Parker and Gibson 1977, 1979; Gibson 1986, n.d.). Although my approach differs in some important ways from Parker and Gibson's, it owes much to theirs, and theirs is the best starting place for understanding the shift point I have outlined.

Extractive foraging can be accomplished with tools or without. Either way it can be described as stereotyped or intelligent, but Parker and Gibson focus on extractive foraging with tools:

Stereotyped tool use is associated with context-specific foraging on a single nonseasonal food source; intelligent tool use is associated with

extractive foraging on a variety of seasonally- and locally-variable encased foods. Intelligent tool use results from trial-and-error and insightful invention of new means to solve a problem. Once a tool-using technique is invented, it may spread through imitation and observational learning in a local population. Intelligent tool use allows species to invent new technology to exploit locally and seasonally variable resources. (Parker and Gibson 1979:371)

For Parker and Gibson, at least two important conclusions follow from a focus on extractive foraging with tools by primates (consult their 1979 article to see how they relate extractive foraging to the evolution of language in hominids). First, “hominid differentiation from the apes was based on a shift from secondary seasonal dependence (as in the case of chimpanzees) to primary year-round dependence on such tool-aided extractive foraging” (1979:371). As I will discuss shortly, the evidence can be interpreted another way as showing a similar level of tool-aided extractive foraging in chimpanzees and early hominids. Parker and Gibson’s second conclusion (1979:372) is that food sharing may have arisen as a secondary adaptation for extractive foraging with tools. Because Isaac’s view of food sharing as an adaptation for hunting and gathering was then dominant, this suggestion was more radical at the time than it sounds now.

The relevance of a focus on food sharing becomes clear upon reading a passage from Gibson (n.d.):

The prehistoric ecological transition to extractive foraging on foods that were both difficult to obtain and process would have resulted in mandatory parental provisioning of post weanling children. Abortive attempts by children to open tough nuts, dig deep tubers from the ground and engage in other complex activities would have resulted in need for parental aid. Many parents would have anticipated their children’s difficulties in accomplishing these tasks and would have come to their aid as soon as interest was evidenced by the child by pointing, vocalizing, reaching, etc. The probable result would have been that certain vocal or manual gestures would have acquired specific meaning within individual mother-infant pairs.

This scenario suggests a relationship between tool-aided extractive foraging and information donation that goes beyond food sharing itself. Indeed, this speculative reconstruction fits remarkably well with comments made by the primatologist Boesch about information donation among the chimpanzees of Tai, Ivory Coast—a population with heavy seasonal dependence on hard-

shelled nuts (see chapter 3). Juveniles at Tai undergo long apprenticeships in learning how to use tools and crack open the hard nuts. Boesch observed some chimpanzee mothers directly guiding their offspring's attempts to carry out tool-aided extractive foraging, and in two cases, he saw maternal teaching of these skills.

Boesch suggests that the complex tool-using skills needed by Tai chimpanzee immatures may be acquired only when true food sharing compensates the immature for the energy devoted to a lengthy apprenticeship. Furthermore, teaching (including the intentional variety implied in Boesch's and Parker and Gibson's formulations, as opposed to the broader definition adopted by Caro and Hauser [1992] and reviewed in chapter 1) might be favored in "situations where the model needs to accelerate the acquisition of a behaviour in an inexperienced individual to prevent any damage to its own reproductive success" (Boesch 1993:173).

Although they need confirmation (see Galef 1992), Boesch's observations add significantly to our understanding of great ape tool use and extractive foraging. Goodall's observations (1973, 1986) also suggest that chimpanzees are the consummate tool-using extractive foragers among primates. Gombe chimpanzees extract termites from mounds and open hard-shelled fruits; they also share food.

With the other great apes, the issue of capacity versus performance reasserts itself. Orangutans, gorillas, and bonobos use tools with dexterity and sophistication in captivity but rarely use them at all in the wild (see reviews by Candland 1987; McGrew 1988, 1992). Orangutans and gorillas solve extractive foraging problems with body size and strength. Parker and Gibson (1977:634) hypothesize that these apes once had the ability to forage extractively with tools but lost it over time when they moved into new habitats in which the appropriate selection pressure was not maintained. Although untestable, this view makes sense of the capacity versus performance disjunction. McGrew (1988:470) may be on target with his comment that "all great apes are smart enough to use tools but they only do so in useful circumstances."

My departure from Parker and Gibson's views can be organized around two points. First, Boesch's chimpanzee data—which were unavailable when Parker and Gibson wrote their original articles—strengthen both Parker and Gibson's proposed relationship between tool-aided extractive foraging and food sharing and my proposed relationship between tool-aided extractive foraging and information donation, but they weaken the suggestion that tool-aided extractive foraging "drove" hominization. Second, many monkeys, some great apes, and, indeed, many nonprimates carry out complicated extractive foraging without tools. Parker and Gibson note this fact but emphasize tool-aided extractive

foraging and its relationship to intelligence. Emphasizing that tool-aided extractive foraging need not indicate meaningful cognitive advances is equally important (King 1986).

The cognitive abilities required for some extractive foraging tasks accomplished without tools may be just as complex as those required for extractive foraging with tools. Some birds, for example, including marsh tits, black-capped chickadees, and Clark's nutcrackers, cache food for future recovery, apparently in the absence of sensory cues. Specific criteria used to assess cognition in foraging (see Menzel and Wyers 1981), including the abilities to take into account stimuli that are temporarily absent, to process and react to a large number of variables simultaneously, and to remember and plan ahead, may be applied to the food-recovery behavior of these birds. The resulting analysis (King 1986) suggests that the foraging behavior of birds may be cognitively as complex as some examples of extractive foraging with tools.

In addition, many questions arise from the analysis of birds' foraging behavior. Is acquiring tool-using skills inherently more difficult and time consuming than acquiring other skills needed for complex foraging? More specifically, how do immature birds of these species acquire information socially about foraging, assuming they do so at all? The purported relationship between extractive foraging with tools and food sharing is a separate question, so long as food sharing is not assumed to require particularly well-developed cognitive skills. Even this relationship, however, has not been tested. Is extractive foraging with tools closely correlated with food sharing in primates other than chimpanzees? How often does food sharing occur in primates that do not engage in tool-aided extractive foraging, as it does among callitrichids? These questions await study.

Parker and Gibson's views on extractive foraging are significant for anthropology. Many of their assertions have been strengthened or maintained in the face of new evidence, and all suggest hypotheses for testing. Their work should be read in the original because I have highlighted bits and pieces, inevitably reducing some complex ideas to summaries.

My view is that extractive foraging with tools was unimportant in hominization but highly significant for the evolution of information donation from adults to immatures. To support this assertion, it must be shown that chimpanzees and early hominids depended more on tool-aided extractive foraging than did monkeys, and that chimpanzees and early hominids shared a similar level of tool-aided extractive foraging. More generally, my view assumes that although tool-aided extractive foraging need not correlate with greater cognition, it does correlate with increased information donation. Tool use can be interpreted as behavior that requires guidance and demonstration in ways

that other foraging behavior does not—and this requirement is sufficient to select for increased information donation (not the *capacity* for information donation).

Judging from the descriptions by Boesch and McGrew of the dexterity and precision chimpanzees must use in tool-aided extractive foraging, it seems safe to assume that even if tool-using skills are not cognitively more demanding than other tasks, they require a longer period of mastery. When tools are used in foraging, precise “right” and “wrong” solutions exist. In order to solve the problem, specific skills already in use by conspecifics must be mastered, or new tools and processes must be invented.

The first point to address is whether chimpanzees and early hominids depended on tool-aided extractive foraging more than monkeys. According to numerous field studies—at least insofar as negative evidence is reliable—monkeys do not use tools consistently in the wild. Many anecdotes refer to occasional tool use by wild monkeys (Beck 1980; Candland 1987), but hardly ever in the context of extractive foraging. Like most great apes, some monkeys show evidence of far more impressive tool-using skills in captivity than in the wild; the distinction between capacity and performance again confounds issues of evolutionary change and behavioral relationships.

The New World cebus monkey is widely considered the best non-ape tool user (see chapter 3). Indeed, captive cebus monkeys are impressive tool users who solve an unusually wide range of problems with tools, leading Parker and Gibson to classify cebus monkeys with great apes in terms of extractive foraging ability. Parker and Gibson suggest (1977:364) that a certain level of intelligence (“tertiary sensorimotor intelligence” in Piagetian terms) arose “in the common ancestor of cebus monkeys and independently in the common ancestor of the great apes and hominids” as an adaptation for extractive foraging through “complex object manipulation.” Visalberghi (1990), who has worked extensively with cebus monkeys, emphasizes, however, that little evidence exists for tool use by wild cebus, and tool behavior by cebus is not qualitatively similar to that known for great apes.

Some debate does exist about the propensity of wild cebus monkeys for tool-use behavior. According to Visalberghi, only one recent, detailed report exists for cebus tool use in the wild (Boinski 1988); it describes a cebus monkey striking a snake with branches. Chevalier-Skolnikoff (1990) observed 31 single acts and 20 bouts (defined as groups of acts that occur in unbroken functional sequences) of tool use during 300 hours of observations on wild cebus monkeys in Costa Rica. Of the 8 types of tool behavior she lists, only 1—probing a hole with a stick—qualifies as extractive foraging. Of the 20 bouts, 17 occurred during aggression, 2 during play, and only 1 during exploration

and feeding. Chevalier-Skolnikoff accordingly notes that her data do not support the hypothesis that primate tool use arose as an adaptation for extractive foraging.

Despite the uncertainty about the amount of tool use by wild cebus monkeys, it can be asserted confidently that they do not carry out tool-aided extractive foraging on a regular basis. The same distinction between capacity and performance occurs with cebus monkeys as with so many other primates.

The underlying mechanisms for tool use may be qualitatively different in great apes and cebus monkeys. As Visalberghi (1990:151–52) explains it, “persistent and vigorous trial-and-error attempts using a variety of external objects” are responsible for cebus’s success at tool use, whereas chimpanzees show evidence of mental representation. Robust and convincing data support this conclusion (see chapter 3). In sum, despite intriguing examples of occasional tool use by wild monkeys, including cebus, great apes are better at tool-aided extractive foraging than are monkeys.

A similar distinction between great apes and hominids is not supported by the evidence. Our knowledge of early hominid foraging and the Tai chimpanzees’ use of tool-aided extractive foraging suggests that australopithecines may not have been significantly better extractive foragers than some great apes. Although this suggestion is speculative, the burden of proof rests with those who support the idea that hominids were better extractive foragers. Many scenarios of early australopithecine foraging focus on adaptation to the savanna and its patchy foods. It will thus be critical to confirm or reject the view that the savanna significantly expanded only well after australopithecines had evolved (see chapter 4). Furthermore, Oldowan tools made by *Homo habilis* show no significant differences from ape tools (Wynn and McGrew 1989). Plausible reconstructions of the early hominid tool kit (Parker and Gibson 1979; Tanner 1981) contain no persuasive evidence to counter the claim that early hominid tools were essentially apelike.

Departing from the classification adopted by Parker and Gibson (1979), I group together apes and early hominids in terms of tool-aided extractive foraging. This classification should not be taken to mean that all apes perform at the level of all early hominids. Rather, it suggests that because some apes, notably some chimpanzees, apparently are as skilled and efficient at (and perhaps nearly as dependent on) tool-aided extractive foraging as were early hominids, there is no compelling reason to suggest that early hominids were better at this behavior than are apes.

The similarity in length of the juvenile period for apes and early hominids fits well with this proposal. Unlike earlier researchers, we now know that apes and australopithecines have roughly equal juvenile periods that are longer than those of other primates (Bromage and Dean 1985; Bromage 1987). The sub-

sequent gradual lengthening of the juvenile period during human evolution must be due to complex factors, but it doubtless allowed more information to be acquired before adulthood and reproduction—and probably required it. When a great deal of information is required to master survival-enhancing technology, then the costs and pressures associated with immatures' acquisition of independent foraging skills should be reduced by donations of both food and information from adults.

Boesch's data and Parker and Gibson's reconstructions of apprenticeships in early hominids bolster the view that tool-aided extractive foraging selects for the donation not only of food but also of information from adults to immatures. The lack of tool-aided extractive foraging by wild monkeys may partially account for the limited information donation they exhibit—in other words, they experience no ecological pressure (at least of the type considered here) toward information donation. A central hypothesis for testing is that the more dependent a particular primate population is on tool-aided extractive foraging, the more information is donated to immatures.

Is the evolution of information donation related to the evolution of cognitive abilities in primates? One possible answer is that important shifts in cognitive ability between monkeys, on the one hand, and chimpanzees and early hominids, on the other, permitted increased information donation. I have already suggested that the differences in extractive foraging abilities between these two groups may not directly relate to cognition. Support for cognitive differences between them comes, however, from the study of other abilities, including attribution. Attribution may be defined as the ability to recognize the mental states of other individuals. Although research into nonhuman primate attribution began over 15 years ago (Premack and Woodruff 1978), only recently has a concentration of talent and energy been devoted to it. Conclusions are still preliminary. As Cheney and Seyfarth (1990:254) phrase it:

Although most of the data are anecdotal, there is strong suggestive evidence that chimpanzees, if not other apes, recognize that other individuals have beliefs and that their own behavior can affect those beliefs. Unlike monkeys, chimpanzees seem to understand each other's goals and motives. They deceive each other in more ways and in more contexts than monkeys, and they seem better than monkeys at recognizing both their own and other individuals' knowledge and limitations.

Evidence setting chimpanzees apart from monkeys in terms of attributional ability can best be appreciated by understanding four experiments, two each on chimpanzees and macaques. In the pioneering study by Premack and Woodruff (1978), the chimpanzee Sarah was shown videotapes of attempted

problem-solving behavior by humans. In one sequence, a human actor tries to reach bananas suspended by a rope from the ceiling (a nice twist on Kohler's [1925] famous experiment with chimpanzees). The video was stopped before the problem was solved, at which point Sarah was shown photographs depicting different potential solutions. Not only was Sarah able to choose the correct photograph for the problem at hand, but she also varied her response according to the identity of the human actor. She chose the correct solution for human actors she liked and incorrect ones for human actors she disliked. Premack and Woodruff (1978:518) suggested that the chimpanzee "imputes at least two states of mind to the human actor, namely, intention or purpose on the one hand, and knowledge or belief on the other"—intention because the chimpanzee assumes the human wants the banana, and knowledge because the chimpanzee assumes that the human knows how to attain the banana.

A recent experiment with chimpanzees focused on the issue of visual perspective taking—the ability to understand how objects and events may appear from another's perspective and that a different visual perspective may cause another individual to have a different state of knowledge from one's own (Povinelli, Nelson, and Boysen 1990). In this study, four chimpanzees (including Sarah) were tested using an apparatus with four pairs of food trays, each covered by an inverted food cup and controllable by handles on one side.

While the chimps watched, human experimenters played the roles of guesser and knower as food was hidden under one cup; the knower hid the food while the guesser was out of the room. When the guesser returned, the knower and guesser pointed to the correct and incorrect locations, respectively (for details see Povinelli, Nelson, and Boysen 1990). The chimpanzee subject then pulled one of the handles on the apparatus. Either the food was revealed and the chimpanzee could obtain it as reward, or the chimpanzee was informed of his or her incorrect choice and shown the correct one. All four chimpanzees consistently chose the correct location significantly more often than the wrong one. Again, the results support the idea that chimpanzees can differentiate among states of knowledge (knowing versus guessing) and can make some inferences about the mental states of others.

The same experiment conducted on rhesus macaques produced a different outcome (Povinelli, Parks, and Novak 1991). The four rhesus subjects showed no obvious discrimination between knower and guesser. These results are consistent with those obtained by Cheney and Seyfarth (1990:231–34) for rhesus and Japanese macaques in another type of experiment. In their study, a juvenile offspring of a high-ranking female was placed in a test area with a subordinate adult female under each of three different conditions: mother (the high-ranking female) visible behind a clear glass barrier (glass condition), mother invisible behind a dark opaque barrier (opaque condition), and mother seated behind a one-way window (mirror condition). In the mirror condition,

the mother could be seen by the other two monkeys but could not see them; this condition separated the mother's apparent presence from her knowledge (Cheney and Seyfarth 1990:232). As might be expected from wild studies showing the influence of kin on behavior, juveniles showed more agonistic behavior toward the subordinate female in the glass than in the opaque condition, and subordinate females threatened or supplanted the juveniles more often in the opaque than in the glass condition.

Comparing the glass with the mirror condition was meant to measure the same ability—visual perspective taking—as did the experiments by Povinelli and colleagues. As Cheney and Seyfarth (1990:233) put it, if the subordinate female was capable of distinguishing between her own and the mother's visual perspectives, she might have realized that the mother, though visible, could not see what was happening. In that case her behavior under the mirror condition should have been indistinguishable from that under the opaque condition.

Results from this part of the experiment were mixed. Some aspects of the monkeys' behavior seemed to indicate the ability to distinguish between the mother's presence and her knowledge, whereas others did not. For example, significantly more subordinate females behaved agonistically under the mirror and opaque conditions than under the glass condition, but all subjects spent more time looking at the mother under the mirror and glass conditions than under the opaque. Cheney and Seyfarth conclude that a likely explanation lies in the subjects' skill in monitoring the mother's apparent attentiveness rather than skill at recognizing the mother's mental state (the state of ignorance).

The results of these four experiments, even considered together, are not definitive, but they do strongly suggest that chimpanzees have more highly developed attribution-related abilities than at least some monkeys. A similar conclusion comes from analyzing reports of tactical deceptive behavior in primates (Whiten and Byrne 1988). Deception may be important to consider when discussing social information transfer. When animals can deceive each other behaviorally, a significant cost or risk is introduced to information donation. If an individual uses or depends on information donated by others, it risks being misled by the donor in order for the donor to accrue some advantage. According to kin selection theory, deception should occur at a higher rate among nonrelatives than among relatives. Because the contexts discussed here for social information transfer likely involve kin, I do not treat the costs and risks associated with deception at any length. Nevertheless, theoretical and methodological perspectives that include dishonest information transfer (Dawkins and Krebs 1978; Kaplan 1987; but see Quiatt and Reynolds 1993) should be included in future research on social information transfer.

What is the likely relationship between attribution and information donation? In previous work, only attribution and teaching have been considered together. Opinion is divided between those who propose a direct relationship

between them (e.g., Cheney and Seyfarth 1990; Boesch 1991) and those who do not (e.g., Caro and Hauser 1992). Caro and Hauser (1992) clearly show that teaching is possible without a teacher's making inferences about mental states. Other forms of information donation may similarly exist in the absence of attribution. It seems likely, however (and Caro and Hauser do not deny this) that attributional ability aids in information donation, particularly in the guidance or teaching of tasks that are components of complex, multipartite skills such as tool-aided extractive foraging.

Alternative Hypotheses

From a look at the role of apprenticeships by immatures, food sharing, and tool-aided extractive foraging in the evolution of information donation, a central point emerges: the prediction of greater selection pressure for increased information donation in populations that depend on tool-aided extractive foraging. I should reiterate, however, that other, very different conditions might have selected for increased information donation instead of or in addition to the ones proposed here. Any activity that requires sustained attention and long-term practice by immatures—an apprenticeship—might create similar selection pressures. A series of alternative hypotheses and predictions should be considered by primatologists.

Future research might start with the question, With what factors does a high rate of information donation co-occur? Keeping in mind the distinction between ultimate and proximate causes, the underlying goal would be to identify possible selection pressures toward increased information donation. Hypothesis testing could be based on observations made across populations, both within and across species. Ideally, the populations would differ in only one potentially significant factor, although realistically this would be almost impossible.

Some significant factors might include fission-fusion social organization (as in spider monkeys and chimpanzees) versus more cohesive and stable groups (baboons and macaques); more rigid dominance hierarchies (cercopithecines) as compared to weaker or absent dominance hierarchies (some colobines); multiple caretaking of infants (langurs) as opposed to more exclusive mother-infant bonds (baboons); degree of frugivory versus folivory, or degree of dependence on patchy versus evenly distributed foods (spider versus howler monkeys or perhaps western lowland versus mountain gorillas); extractive foraging with tools (chimpanzees) and without tools (gorillas); sharing of nonembedded foods (callitrichids) and of embedded foods (chimpanzees); sharing of embedded foods obtained with tools (chimpanzees) versus embedded foods obtained without tools (orangutans); capacity

for attribution (chimpanzees) as opposed to the apparent lack of such a capacity (rhesus macaques); and a well-developed capacity for deception (apes and some monkeys) versus a less well-developed or absent capacity (other monkeys). The challenges in testing for these factors will be, among others, to find appropriate controls and to eliminate alternative hypotheses where possible. Progress can be made both by working with captive populations and by using experimental controls in the field. A similar set of questions could be posed for other aspects of social information transfer, namely, for degree and kind of information acquisition exhibited by immatures.

The paleoanthropological evidence suggests that sometime after *Homo habilis*, most likely during the period of late *Homo erectus*, and again with *Homo sapiens sapiens* at around 40,000 years ago, shifts occurred in information donation that were similar in magnitude to the one separating monkeys from great apes and early hominids. Diachronic approaches should be applied to these shift points as well. Parker and Milbrath (1993), for example, focus on the role of organized planning in human evolution. Their approach is gradualistic, fits with paleoanthropological evidence, including ecological data, and provides a good starting place for modeling change in information donation at later shift points.

I have suggested that behavioral changes in information donation over time can be modeled using diachronic anthropology. The next step for anthropologists is to examine in greater depth the question of change over time using various aspects of social information transfer at various points on the primate continuum. My next step in this book is to address the significance of a focus on information donation for understanding one of the central issues of anthropology, human uniqueness and the role of language in human evolution.