

## Primate Infants as Skilled Information Gatherers

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**Abstract:** None available.

**Full Text:** Headnote ABSTRACT: An evolutionary perspective on human infancy suggests that the active infant, skilled at information-gathering and -prompting from adults, and at coordinating its behavior with that of adults, has been shaped by millions of years of natural selection. Infant monkeys and apes are skilled in these ways because they have to be; adults rarely donate information to them, although the contexts in which they do are likely to have evolutionary significance. Ecological shifts over time may have "driven" selection for an information-donating primate adult, an experienced social partner who is motivated to guide infant behavior and to coordinate its behavior in structured routines with that of infants. INTRODUCTION Many anatomical, physiological, and behavioral traits of human infants (and indeed of humans of other age classes) developed during millions of years of evolution shared with our closest living relatives, the monkeys and apes. Our understanding of behavior in human infancy can thus be promoted by use of an evolutionary perspective (e.g., Peters, in press; McKenna et al., 1993) in which anthropologists attempt to identify those features of human infancy which stem primarily from our evolutionary legacy shared with other primates and which, by contrast, have evolved since the split from our common ancestor with chimpanzees at perhaps six million years ago. In making this distinction, anthropologists hope not only to describe behavioral shifts over time but also to model shifts in certain "driving factors" e.g., ecological selection pressures-that might underlie such a behavioral change. In this paper, I suggest that a significant shift occurred during primate evolution in the relative roles of adults and infants in the social acquisition of information by infants. In monkeys and apes, infants are responsible for obtaining information from adults who may be willing to share accumulated knowledge in a passive way (e.g., by allowing infants to observe and imitate them, or to initiate and maintain social interactions with them that result in potential information transfer) but who do not actively "donate" such knowledge or information except rarely in restricted contexts. Contrast this with the heavy reliance in human societies on adults altering their own behavior, directing it towards infants and coordinating it with infant behavior through physical intervention, nonverbal or verbal guidance including structured routines, and other forms of teaching. Human infants actively seek and respond to interaction with adults, much as in monkeys and apes, but receive greater donations of information in more contexts than do monkey and ape infants. By describing and modelling this shift towards greater adult donation of information over time, the cross-disciplinary interest in the active human infant (e.g., Bruner, 1983; Rogoff, 1990; Trevarthen, 1993), that is in an infant capable of sophisticated interaction with its world at a young age, can be enhanced. On an evolutionary perspective, human infants are skilled in abilities to interact with and prompt information donation from adults because of their evolutionary history as primates who required information-extraction skills in order to survive. Special skills of the human infant are overlaid upon the nonhuman primate ability to set up interaction with and extract information from adults. Some background information concerning definitions of terms is needed at this point. I use social information donation to refer to a subtype of social information transfer in which a particular social interaction increases the probability that one individual will come independently to exhibit a behavior initially in the repertoire of the other (Galef, 1988, p. 13). More specifically, to qualify as social information donation, the social interaction must involve directed action or message-sending on the part of one individual ("the adult"), more experienced or in possession of more knowledge than another ("the immature"), with the result that the immature obtains, or potentially could obtain, more information than it otherwise would. Thus the adult alters its own behavior, directing action in some way towards the immature. A rigorous way to assess whether an adult's

directed action actually results in information transfer to an immature might include measuring whether the two participants show increased homogeneity of behavior over some specified time period (Galef, 1988), but this has rarely been accomplished in ethological studies (see King, 1991, in press, for details and qualifications pertaining to these definitions, including a discussion of how the criteria for social information donation differ from those for social learning). For our purposes, we can identify probable cases of social information donation by one key feature-adults directing some action or signal to immatures. In social information acquisition that occurs in the absence of information donation, the immature takes primary responsibility for acquiring information from an adult who engages in its routine behavior without directing action or messages at immatures. Comparison of two hypothetical scenarios will illustrate this distinction. In the first, a foraging monkey travelling with her offspring passes a fig tree laden with both ripe and unripe fruit. The mother directs a food call towards her offspring (i.e., she refrains from calling in similar contexts when she is travelling alone). The immatures approach the tree and begin to eat the ripe fruit. In the second, the same subgroup of monkeys passes the same tree, but the mother does not call; she enters the tree and begins to feed on ripe fruit. Her offspring surround her but she ignores them, although she allows them to observe her feeding behavior at close range and to take scraps of food that fall around her as she eats. In both cases, information is likely transferred from adult to immatures, but only in the first case are the criteria for social information donation met. In writing about humans as compared to other primates, it is appropriate to note my bias towards continuity theory (see, e.g., Gibson, 1990, 1994). As a behavioral primatologist and anthropologist, I predict that (1) for most human behaviors, precursors can be found among monkeys and apes, and (2) quantitative rather than qualitative change marks the evolution of behavior across the primate continuum moving from monkeys to apes to hominids to modern humans. I prefer to adopt definitions and criteria that are not species-specific, thus enabling evolutionary analysis to proceed free of constraints imposed by use of human-species-specific definitions (Cartmill, 1990; King, 1994). In the next section, I will describe some salient features of infancy, or more precisely of adult-infant interactions, among monkeys and apes. These will be compared to human behaviors, revealing the shift in infant and adult roles that I have been describing, and leading to discussion of quantitative changes in selection pressures over time.

#### INFORMATION ACQUISITION IN MONKEYS AND APES

Primate infants have long been reputed to acquire information and skills via observational learning and imitation (Kawamura, 1959; Jay, 1963; Goodall, 1973, 1986), that is, to gradually conform to adult behavior via relatively passive information-acquisition skills. There is obvious validity in a perspective that focuses on skills acquired by infants from close observation of adults, particularly the mother. The mother-infant bond in monkeys and apes is intense, with the infant initially so close-both physically and in terms of attachment-to the mother as to form almost a single unit with her (Rowell, 1975). Frequent opportunity exists for various forms of social learning, including observational learning, social facilitation, imitation and the like (see Galef, 1988), first with the mother and eventually with other close associates (such as matrilineal kin) as the infant's world expands out gradually from the bond with its mother (e.g., J. Altmann, 1980; Berman, 1982; Goodall, 1986). It is logical to suppose that these types of social learning might be important in adult-infant information transfer, but social learning is difficult to study rigorously in the field (Galef, 1988) and as a result, much debate remains about the specific mechanisms that actually operate in any given instance. Some long-accepted views have recently come under scrutiny. The most famous case within primatology of "cultural transmission," acquiring the habit of washing sweet potatoes from other group members by Japanese macaques (Kawamura, 1959) may not represent social learning in the way so long characterized in textbooks of anthropology and psychology (Galef, 1992). Further, the ability for monkeys and apes to imitate others' behavior in general is under debate (contrast Visalberghi & Fragaszy, 1990, and Tomasello, 1990, with Russon & Galdikas, 1993). More significantly for our purposes, a handful of ethologists (e.g., Rowell, 1975; Dolhinow, 1991; Owings, 1994; Peters, in press) has pointed out that the focus in socialization studies tends to be on how the final product, the adult, is produced. Adult behavior is taken as the norm with infant and juvenile behavior tracked for comparison to this norm. These

same ethologists, especially Dolhinow and Rowell, have advocated paying increased attention to the two-way nature of socialization processes, i.e., to the active role of the infant in shaping its own socialization and the behavior of others around it. Infants show capability for behaving interactively with adults to increase their chances of obtaining information from more experienced individuals. This shift in focus to the active infant is one important way to study what goes on in information transfer beyond observational learning and imitation. A second way is to assess adult behavior more rigorously for active guidance and teaching. The issue of active intervention and teaching among monkeys and apes has been neglected, and even since the recent explosion of interest in the phylogenetic basis of teaching behavior, the topic has usually been approached in one of two relatively limited ways. Teaching is viewed either dichotomously, that is, as absent in monkeys and apes but present in humans because defined with reference to uniquely human traits, or, if admitted as potentially present in nonhumans, as having implications for adult cognition. Recent evaluations of teaching in monkeys and apes (e.g., Cheney & Seyfarth, 1990; Boesch, 1991; Tomasello et al., 1993) have related presence or absence of nonhuman teaching to ability for attribution, that is, for taking another's perspective, as when an adult recognizes an immature's state of ignorance. Teaching and other forms of information donation can, however, be viewed in a continuum without recourse to characteristics of complex cognition (King, 1991; Caro & Hauser, 1992), and as having significant implications for infant as well as adult cognition. Keeping in mind these two approaches to evaluating adult-infant interactions, what conclusions can be reached about the relative roles of infant and adult primates in social information transfer? I will begin my evaluation within the foraging context for two reasons. First, it appears to be an arena in which stark contrast between infant and adult contributions to social information transfer can be found, but one which nonetheless shows variation with phylogeny and ecological context; it thus may carry important clues to behavioral shifts over evolutionary time. Second, it is the behavioral area which I know best, allowing me to proceed from example (taken from my own research) to generalization. Foraging Behavior During my study of free-ranging baboons (*Papio cynocephalus*) at Amboseli National Park, Kenya, I saw no clear instances of social information donation by adults in the context of feeding (see King, 1989, in press, for detailed analysis). That adults, including mothers, did not intervene in or guide the foraging behavior of young infants is interesting for several reasons. First, the mother-infant bond is as intense in this population (J. Altmann, 1980) as in many other Old World monkey populations. Second, mothers and other matrilineal kin (grandmothers, aunts, sisters) do intervene to help or rescue infants who become embroiled in risky or threatening social situations, e.g., involving large aggressive adult males. Although this type of intervention may not amount to social information donation (see below), it does demonstrate that mothers closely monitor and protect their infants in certain behavioral contexts. Third, development of independent foraging carries with it problem-solving challenges; harm may come to infants who make the "wrong" foraging choices. Baboons are eclectic omnivores. Although they eat a wide variety of foods they are extremely selective in two ways. They choose foods to eat from an unusually wide array of potential sources, and they extensively manipulate many items to separate the edible, nutritious parts from parts low in nutrients or high in toxins (Altmann & Altmann, 1970; S. Altmann, personal communication). Baboon infants thus face a special subset of the foraging challenges that confront all animals. Despite the logical presumption that maternal (or other adult) guidance should increase infant survival and reproductive success, and thus that it would be selected for, no adult guidance of foraging was noted in the Amboseli population. Using a mix of focal-animal, scan, and ad libitum sampling techniques (J. Altmann, 1974), I observed for 1000 hours the food-related behaviors of 19 infants, aged between two and 32 weeks, in two baboon groups. During that time, I saw only nine instances of behavior that might be considered adult intervention in infant feeding. All but two of these can be explained as adults trying to discourage infants' interference in their own feeding. In both remaining cases, adults prevented infants from mouthing pieces of a grass that is part of this population's diet. In none of the nine cases did infants avoid the foods in question during subsequent observed foraging bouts, making it unlikely that these instances amounted to social information donation. Judging from my data, it is far more common in any

case for adults to ignore infant food choice (at least as far as a human observer can judge), even in rare instances when infants sampled foods outside the population's typical diet. In one instance, a female infant became ill apparently as a result of such atypical food choice. Her mother, sitting quite nearby, ignored her food selection and subsequent signs of distress. Further, no instance of active food-sharing by adults to infants was seen in my study or by other observers (e.g., J. Altmann, 1980) of this population. Infants in my sample spent only 11% of their time feeding independently, versus, for example, 29% suckling from their mothers. Adults, by contrast, spend about half their day foraging (Post, 1982). Infants were often in close proximity when adults fed, yet despite frequent opportunities for adults to guide, teach about, or otherwise intervene in infant food selection or other aspects of foraging, behavior of both infants and adults is consistent with the conclusion that infants took responsibility for setting up social interactions to acquire information from adults about foraging. Infants behaved actively towards adults in ways that might increase their chances of acquiring information about feeding. Three behaviors illustrate this tendency particularly well. (1) Infants snatched scraps of food from the area immediately surrounding feeding adults, a behavior termed tolerated scrounging (see Stein, 1984). (2) Infants and juveniles initiated muzzle-muzzle behavior (sometimes called muzzle sniffing) with adults more often than expected based on age-sex composition of the two groups, and did so disproportionately often when adults were feeding. Infants may have obtained cues, via the close range olfactory and visual inspection accompanying such muzzle-muzzle behavior, about population-typical diet. (3) Perhaps most strikingly, infants were selective in co-feeding with adults, that is, in feeding upon the same food type (items eaten were broadly classified into the following types: corms, leaves or stolons, fruit, seeds, gum, other) at the same time as adults. Infants preferred to co-feed with adults when the foods eaten were harder rather than easier to process. They co-fed at the highest rate on corms and at the lowest on leaves. Corms are important foods for baboons (Post, 1982) because they are nutrient-rich and available year-round. They are located underground, and as a result infants lack the strength or dexterity to obtain them until about six months of age (Altmann & Altmann, 1970). Co-feeding with adults on corms thus makes good sense for infants, compared to co-feeding on other foods that are more easily accessible to them. Notably, Stein (1984:230), working at Amboseli, observed infant baboons taking pieces of corms more than any other food item when scrounging scraps from adult males. Amboseli baboon infants thus took an active role in acquiring information about foraging at a young age, prior to onset of weaning. The literature on primate foraging indicates that Amboseli baboons are representative of a general pattern, that is, monkey and ape infants generally must rely on their own information-extraction skills in the absence of social information donation from adults, or use these skills to prompt such social information donation. Unfortunately, few field studies have yet chronicled in qualitative or quantitative detail the ontogeny of feeding behavior in monkeys and apes. To date, however, the active infant appears to be common in primate foraging behavior whereas instances of social information donation by adults-except in food sharing, as discussed below-are rare. Unusually detailed results of one foraging study (Whitehead, 1986) show that infant wild mantled howling monkeys (*Alouatta palliata*) in Costa Rica use a mix of social and individual learning in acquiring foraging skills. Nothing that would qualify as social information donation by adults was seen in this study, although adults were less likely to experiment with foods in the presence of infants. Infants use social means, mostly social behaviors maintained by the infant (e.g., restricting feeding to when the adult feeds and visually monitoring adult feeding) to learn about leaves, but learn about fruits independently of social interactions. Infants sampled fruits and fruit-like objects that adults did not eat, but did not experiment with leaves. This difference is consistent with a view of the infant as able to acquire information from adults in just those situations where it would be most helpful, because leaf-eating in this population carries more toxin-related risks to the infant than does fruit-eating (Whitehead, 1986). The situation reported for Amboseli baboons and Costa Rican mantled howling monkeys appears, judging from published reports, to represent a kind of monkey "norm"-characterized by active infants and no social information donation by adults-but several qualifications are necessary. Even where social information donation is clearly absent, one cannot conclude that infants are

actively acquiring information on their own from adults. In some cases, as with Peruvian squirrel monkeys (*Saimiri oerstedii*) (Boinski & Fragaszy, 1989), infants rarely monitor experienced foragers, including their own mothers. Infants in this population are less likely, for example, to be in proximity to adults who are foraging than doing something else. Further, new methods may show that adult monkeys donate information to immatures in ways previously unsuspected or unstudied. Referential vocal communication by adults, that is, vocalizations that refer to specific aspects of the signaller's environment, might encode information useful to infants in acquiring foraging skills. Although intriguing hints exist of such referential signalling in foraging (e.g., Dittus, 1984; Hauser & Marier, 1993) it is premature to consider these as cases of social information donation because it is unclear whether the messages are directed at infants or simply comprise part of the adult's normal behavioral repertoire. Finally, where food sharing occurs, social donation of information can also be said to occur. Food sharing behavior is absent in most monkey populations; transfer of food items from adults to infants typically occurs via the type of tolerated scrounging mentioned for Amboseli baboons (Feistner & McGrew, 1989). Nonetheless, there are exceptions in which food sharing is active and adults voluntarily transfer food items to infants (thereby altering their own behavior and directing action at infants, with the behavior qualifying as social information donation). Among monkeys, food sharing is most elaborately developed in callitrichids, the small-bodied and usually monogamous marmosets and tamarins. In some cases, and consistent with the view taken here of the active primate infant, infant callitrichids initiate or prompt food transfer from adults (e.g., Ferrari, 1987), but in other cases, adults hand over items in the absence of any obvious prompting. Three features of food sharing among monkeys are important to keep in mind. First, it is not independent of ecological context, being "particularly developed in species that feed on high-energy foods for which the collection, processing, or capture depends on special skills or rare opportunities" (de Waal, et al., 1993, p. 73). second, it occurs at least sometimes because of infant-initiated behavior and prompting. Third, whatever its characteristics, it occurs rarely compared with the frequency and distribution of tolerated scrounging, which by definition is infant-maintained. The occurrence of food sharing, however important in terms of evolutionary significance (see below), thus does not meaningfully alter the picture of monkey infants as sophisticated information gatherers who must act on their own, in the absence of social information donation from adults. Among apes, too, infants are active information extractors. Tolerated scrounging and co-feeding are behaviors used by infant mountain gorillas (*Gorilla gorilla beringei*) (Watts, 1985) and chimpanzees (*Pan troglodytes*) (Goodall, 1986). cases of adult intervention in infant food choice or foraging behavior—except in food sharing as described below—are reported only anecdotally. The best known of these cases come from the long-term studies of wild chimpanzees carried out in Tanzania, at Gombe (Goodall, 1973; 1986) and Mahale (Nishida et al., 1983) (see also Watts, 1985, for gorillas). A typical anecdote is one in which a mother or other female relative snatches food from an infant's hand or mouth before the infant is able to consume it. Sometimes the snatched food item falls outside the group-typical diet, but because the data are anecdotal it is not known whether infants avoided choosing the same food in the future. Apes may engage in this kind of food intervention somewhat more often than monkeys, but one is still struck by the rarity of such reports. What about food sharing? Among apes the same three patterns appear to be in place as discussed for monkeys, although food sharing may occur in wider distribution and at higher rates in ape than monkey populations (see, e.g., Horr, 1977, for orangutans; Kano, 1992, for bonobos; Goodall, 1986, and Boesch & Boesch, 1990, for chimpanzees). An active role for infants is often indicated by field reports. During their first year, infant chimpanzees at Mahale solicit food almost once every three minutes during maternal feeding (Hiraiwa-Hasegawa, 1990). Just as with Amboseli baboons, infant behavior varied according to food type, with a higher rate of solicitation observed for hard-to-process foods by infants in the first six years of life. Bard's (1990) study of provisioned orangutans (*Pongo pygmaeus*) in Indonesian Borneo indicates that even very young infants manipulated their mothers to gain food items from them, for instance by pulling on parts of the mother's body or using begging gestures. Where the role of infants in prompting food transfer is less clear, there may still be a relationship between hard-to-process foods and food

sharing by adults to immatures, as in the Tai forest population of chimpanzees (Boesch & Boesch, 1990; Boesch, 1991, 1993). Tai chimpanzees use both organic and stone tools as hammers to open hard, tough nuts, a process considered by Boesch to be the most demanding manipulatory technique carried out by wild chimpanzees. Despite the long period of immaturity in chimpanzees, nut-cracking with tools is fully mastered only in adulthood. During this period of skill acquisition or apprenticeship by immatures, mother chimpanzees donate nuts and information to their offspring. The coupling of high rates of food sharing with maternal behavior interpretable as direct guidance and teaching of immatures' tool-using skills (Boesch, 1991) may enable the long period of apprenticeship that characterizes the immature period in this population (Boesch & Boesch, 1990). Although data are still too scant for hard and fast conclusions (the role of referential vocal communication in ape behavior is particularly unclear), it seems that the role of the nonhuman primate adult in foraging varies both with phylogeny and ecological context. An increase in social information donation in apes as compared to monkeys, and in ecological settings where primate populations depend on hard-to-process foods, may occur (although the degree of interaction between these two variables is unknown). This hypothesis should be tested across populations and species. The need to perform tool-aided extractive foraging, a term (see Parker & Gibson, 1979) descriptive of the type of behavior observed among Tai chimpanzees in which tools are used to acquire food that is hidden or embedded (as the edible parts of nuts are in tough shells), may be particularly important as a selection pressure for social information donation (see below). Other Social Behavior How do the proposed patterns of social information donation in the foraging context compare to patterns in other contexts? This issue is too large in scope to consider thoroughly here, where I can only briefly examine some other types of primate social interactions. Adults intervene in social behavior involving infants in a variety of ways. When they protect infants from potential harm from other group members by threatening or punishing the other animals involved, there would seem to be no basis for inferring social information donation. What about, however, when infants are retrieved differentially from, or encouraged differentially to participate in, encounters with conspecifics? Intriguing hints about this phenomenon come from studies of wild and captive rhesus macaques (*Macaco mulatto*). Berman (personal communication) notes that some rhesus mothers provide "differential cues" to both their infants and to potential interactants with those infants. These cues may relate to the mothers' own arousal states or to potential outcomes of interactions. Mothers sometimes prevent interaction between their offspring and other rhesus by grabbing the infants and distracting them, de Waal (1990) indicates that rhesus mothers carry out "double-hold" behaviors in which they pick up infants of other females and clasp them together with their own infants. The key here is that infants to be clasped were chosen with a preference for high rank rather than randomly. Might the behaviors noted by Berman and de Waal involve social information donation? Might punishment of infants themselves in social situations amount to the same thing? Few primatologists have considered social behavior in this light (but see Cheney and Seyfarth, 1990, pp. 224-225). Data regarding social information donation in other contexts are also scarce or present an unclear picture. Adults may play a role in the ontogeny of communication skills by encouraging or punishing correct call production of infants. Data on Amboseli vervet monkeys show that development of alarm calling for predators, in which acoustically distinct calls refer to specific predators, may be affected by adults encouraging and punishing infants' call behavior (Hauser's data, Caro & Hauser, 1992, p. 161). Cheney and Seyfarth (1990, p. 225), however, conclude that active instruction by adults is absent, noting (as does Hauser) that adults are no more likely to give second alarms (a potential reinforcer) to infants who call correctly than to adults who do. In cases elsewhere involving other behaviors, direction of adult behavior is clearer, as when Peruvian squirrel monkey adults vocally warn infants of toxic or predatory animals in the environment (Boinski & Fragaszy, 1989) or when monkey mothers guide the development of locomotion skills in their infants (e.g., J. Altmann, 1980, p. 130; Milton, 1988, p. 292). Primatologists should endeavor to build up a "data bank" of such observations. Immediate goals should be to compile enough observations to get an idea of whether high levels of social information donation correlate with other features—phylogenetic, ecological, or behavioral—and then to test

hypotheses based on these preliminary indications. At present, the bulk of evidence from primatology suggests that monkey and ape infants are skilled at information-gathering because they have to be, that is, because adults cannot or do not donate information to them. In some cases, infants prompt social information donation. Typically, adults go about their own behavior, rarely directing it towards infants or coordinating it with that of infants. Where exceptions to this pattern exist, they may have evolutionary significance, as is discussed below. Adult-infant interactions involving information transfer in humans must first be contrasted to the picture developed here for monkeys and apes.

#### SOCIAL INFORMATION DONATION IN HUMANS

We know surprisingly little of the precise mechanisms that operate in or are required for information transfer from human adults to infants in social situations, at least in the non-laboratory "natural settings" favored by anthropologists. This lack of data can be traced to what Ingold (1993, p. 526, see also Peters, in press) calls the "shameful neglect, on the part of anthropology, of children and their development"-as opposed to of parental or caretaking behavior-that persists even into the 1990s. Two hallmarks of social information transfer in humans can nonetheless be pinpointed, the first marked by continuity with other primates and the second by a fairly large, although quantitative, gap with them. Among humans, the infant is an active gatherer of information from adults and shows skill in prompting information donation from adults. Adults, however, engage in far greater rates of social information donation, i.e., their behavior is altered, infant-directed and based on coordination with the infant more often. At the outset it is important to stress that, despite the attention paid in American and European culture to teaching of immatures via speech and language, adult participation in social information donation need not be verbal: It is clear that we do not usually go through a point-by-point explanation of the process when we teach our children how to negotiate their way around the house or to close doors. Much culturally transmitted knowledge seems to be passed on in ways unknown to us. Perhaps in highly schooled societies this fact is misleadingly obscured by the prominence of explicit instruction, but in non-industrialized societies most of what takes people's time and energy-including such practices as how to wash both the body and clothes, how to cook, how to cultivate, etc.-are learned very gradually through imitation and tentative participation (Bloch, 1991, p. 186, see also Kogoff, 1990). Bloch's description, though on target in emphasizing the nonlinguistic nature of some information transfer, slights the critical role of the active adult. Human children are indeed both skilled imitators, far better than monkeys or apes on the current reading of the evidence, and skilled information gatherers, but apparently these skills are not always enough for efficient information acquisition. Adults (or older siblings, etc.) guide or intervene in immature behavior in a variety of contexts. There has even developed a particular kind of adult-infant coordinated behavior, termed a "structured routine," that has been observed cross-culturally to facilitate information or skill acquisition by infants (Bruner, 1983; Peters & Boggs, 1986; Savage-Rumbaugh et al., 1993; Tomasello, 1992). Although structured routines need not involve speech, because they have been most thoroughly described for child language acquisition, they are often defined with reference to verbal interaction: 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 & Boggs, 1986, p. 81). The term interindividual routine is used to mean a more or less regularly sequenced set of interindividual interactions that occur in a relatively similar manner on different occasions. The sequence of interactions may vary, as may the words used in connection with the interactions; however, each routine is carried out for a specific purpose (Savage-Rumbaugh et al., 1993, p. 25). Accounts of structured routines tend to emphasize (1) their predictability and (2) the apparent underlying motivation of both child and adult for establishing a joint attentional focus. As Peters & Boggs (1986:84) put it, certain configurations of time, place, participants and goals tend to occur over and over again. The routine becomes predictable and, as a result, the child comes to expect certain behaviors from her caretaker, and comes to know how she is expected to respond. Subtle changes in the routine, induced by the caretaker and marked or highlighted by him, may in turn induce changes in the child's response (or conversely the child's behavior may induce changes in the caretaker's behavior). We see here more than just shared

activity; structured routines are apparently based on motivation of both parties to establish a shared focus on some aspect of their environment (Tomasello, 1992). This motivation might even be described as a need felt by both participants for coordination and reciprocity, at least as inferred from observations that infants may become upset "when the adult's behavior is not contingent on theirs, that is, when they are not truly interacting jointly," and that infants may then make concerted efforts to correct the situation (Tomasello, 1992, p. 79). Adults, for their part, alter their own behavior in ways that suggest they are motivated to stay in tune with infants. The widely-studied phenomenon of motherese (Snow, 1977; Richman et al., 1988; Fernald, 1992) is a good example. Prosodie modification by adults in a variety of cultures occurs in use of infant-directed speech. Modification includes the features of high mean pitch, higher pitch maxima and minima, greater pitch variability, shorter vocalizations and longer pauses. This altered vocal behavior elicits attention and arousal very early in infant life, with characteristic reactions of infants observable long before such speech is employed for linguistic-related teaching. It is important to emphasize that the role of the infant in this "duet" is as critical as that of the adult. As Savage-Rumbaugh et al. (1993, p. 32) see it, for instance, "the 'driving force' behind language acquisition is not the caretaker; rather, it is the desire of the child or ape accurately to predict what is going to happen to him or her next that motivates the attention towards the acquisition of vocal and gestural transition markers" (they refer here to "linguistic apes" in enriched captive environments). Structured routines in language acquisition is likely to be a topic familiar to readers of this journal, and has been described thoroughly elsewhere, as the above-cited references attest. I refer to them here only as a well-known illustration of my general point, that social information transfer in humans occurs more often as a result of coordinated action between active infants and active adults than in nonhuman primates (although once again, it is important to acknowledge that human infants may acquire information in other ways, see Rogoff, 1990). Even when, as noted above, anthropologists focus on the role of parents or caretakers rather than of children themselves in crosscultural studies, details of adult-infant interactions relating to social information transfer are provided rarely. That human adults feed their juveniles as well as infants, for example—a situation unique or nearly so among primates—has only recently been modelled instead of taken for granted (Lancaster & Lancaster, 1983). We do know that caretakers use a wide variety of techniques to control immature food consumption (Dettwyler, 1989). In some cultures, children are given a great deal of autonomy in deciding what and how to eat, but in most cultures adults use techniques—or structured routines—involving force-feeding, physical punishment, encouragement, or rewards designed to guide infant feeding. Explicit training may also be employed by parents to guide development of very young children's subsistence skills (with subsistence here conceived of more broadly than just feeding), as the Aka Pygmies of Zaire do in training their children in the use of small knives, axes, and spears (Hewlett, 1991) (for other examples, see Whiting and Edwards, 1988). In sum, what is interesting from an evolutionary perspective when comparing infant-adult interactions in humans to those of other primates is that the active, information-gathering primate infant was apparently not enough, and at some point the active, information-donating adult was selected for. Before considering possible reasons for this shift, it is worth entertaining an alternative possibility, that greater continuity in social information donation exists than we can currently see because few researchers are asking questions that might reveal such continuity.

**STRUCTURED ROUTINES: CONTINUITY OR DISCONTINUITY?** One issue not explicitly considered in the above comparison of adult-infant interactions across species is whether monkeys and apes exhibit structured routines. This particular topic has received little attention by primatologists; in fact, to my knowledge only two researchers (and their colleagues) have addressed it. Fernald (1992) states that motherese shows no phylogenetic continuity, but does not support her claim with a review of maternal-infant communication practices in other primates. Tomasello et al. (1993), on the other hand, have supported with research results on captive chimpanzees their conclusion that nonhuman primates are incapable of constructing activities based on joint attentional focus because they are incapable of taking another's perspective, i.e., of attribution. In keeping with an evolutionary perspective, it is preferable to use criteria for structured routines that do not depend upon



behaviors usually thought to be unique to humans, e.g., speech, complex gestural language, or the ability for complex attribution. Possible non-species-specific criteria for structured routines might include the features discussed above, predictability and motivation to maintain joint attentional focus, when these are decoupled from human behaviors and linked instead with non-species-specific criteria for social information donation. Measuring predictability seems relatively straightforward, whereas assessing motivation presents difficulties; nonetheless, a kind of proxy criterion to measure motivation for joint attentional focus could be derived. If both parties work to coordinate their behaviors and to maintain cooperation in the face of disruption-with or without speech and language-motivation might reasonably be inferred. With such criteria in place, a non-anthropocentric search for animal precursors to human-typical structured routines might take place. A similar procedure might be followed in searching for continuities and discontinuities in other aspects of social information donation (King, 1994).

**BEHAVIORAL SHIFTS OVER TIME: WHY?** A thorough consideration of how and why the shifts proposed here in infant and adult roles in information acquisition came about is beyond the scope of this paper (see King, in press), but some brief discussion is needed by way of conclusion. The perspective adopted here fits well with the modelling by other anthropologists of both ultimate and proximate factors in behavioral evolution. One possible ecological (ultimate) selection pressure for increased social donation of information involves shifts in resource type and accessibility over time, and hence in skills needed for successful foraging behavior (Parker and Gibson, 1979; King, in press). On this theory, a role for increased intervention, guidance, etc., by adults would be selected for in populations where primate immatures are forced to devote much time and energy to learning foraging skills. One might ask, however, why such a prediction is not supported by data from populations such as Amboseli baboons, where infants must master complicated foraging tasks but where no social donation by adults is known. It may be that tool-aided extractive foraging, as seen among apes and as is particularly welldeveloped in Tai chimpanzees, may represent a kind of threshold for selection. Even if such tool skills are not necessarily more cognitively demanding than other complex foraging tasks (King, 1986), they may well require more investment of time and energy by immatures who must perfect fine-tuned manipulatory sequences to solve problems (McGrew, 1992). Paleoenvironmental reconstruction for the time period of late ape-early hominid evolution is consistent with a picture of increasing need over time for tool-aided extractive foraging (see King, 1986, and references therein). My perspective is equally consistent with a focus on proximate mechanisms of adult-infant interaction (Borchert and Zihlman, 1990; Gibson, in press; see Mason, 1979). Borchert and Zihlman (1990) insist that anthropologists look beyond selection pressures on adults. In writing about the origins of language, they emphasize behavioral discoveries by hominid infants, as when they suggest that: the transition to vocal tool-using initially occurred not primarily because natural selection favored adults who were somehow more competent with symbols, but because it favored infants who were more successful at using vocalizations to manipulate their mothers' behavior ... We suggest that babies ... were opportunistically making use of soft vocalizations in order to coordinate their activities with their mothers (1990, p. 34). Borchert and Zihlman relate this increased need for infant-adult behavioral coordination to the demands of emerging bipedalism in early hominids. An ontogenetic perspective such as this need not, however, be considered separately from ecological selection pressures (Parker and Gibson, 1979; Gibson, in press), nor need the starting point be with hominids instead of earlier primates. As ecological conditions become increasingly unpredictable (Mason, 1979) or as resources increasingly demand more complex, tool-based foraging skills, immatures' need for joint attentional focus with adults and for prompting information donation from adults would increase, just as would adults' motivation for donating information to infants and for participating in structured routines with infants.

**SUMMARY** An evolutionary perspective on social information transfer in primates suggests that the guiding, teaching adult, motivated to alter its behavior and to donate information to immatures frequently and across a variety of contexts, is a relative novelty in primate evolution. By contrast, the active primate infant has been shaped by countless years of natural selection. Infant monkeys and apes are excellent information-gatherers because they have to be in

order to survive. Primatological data on foraging behavior are particularly useful in clearly indicating a role for the active primate infant. Social donation of information by adults (such as in food sharing) occurs rarely but appears to vary predictably with phylogeny and ecology. The active role of the adult evolved incrementally during the long period of primate evolution, perhaps driven by ecological selection pressures such as those related to tool-aided extractive foraging, and in concert with increasing need for immatures to coordinate their behavior with adults.

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