thing at all about his intelligence test score as a child or as an adult?

In 1949, Bayley reported the results of a long-term study she had conducted to answer this question. She found no correlation between a baby's test score and the same child's later score on intelligence tests. Psychologists concluded that there is too little continuity in development for anyone to predict the intelligence of babies.

Bornstein points out that Bayley's results coincided well with the philosophy of our democratic society. Everyone can have an equal chance in life and, given the right environment, "anyone can become anything."

At the same time, psychologists continued to study babies, devising ever-better ways to determine what babies know and can do. "Babies used to be considered tabulae rasae," says Norman Krasnegor of the National Institute of Child Health and Human Development. "As techniques for asking questions of babies became more powerful, the notion of the baby as inept went away. Now we know that babies are very very capable."

The new ways to study babies also allowed investigators to ask again whether they can use their test results to make predictions. The methods for studying babies were developed more than a decade ago, but because it is necessary to do long-term follow-ups to look for predictive effects, researchers are only now beginning to accumulate the data they need.

The tests used by Bornstein and Rose were developed by Joseph Fagan and his colleagues at Case Western Reserve University to determine how babies respond to and process visual information. Psychologists show infants photographs of faces or abstract patterns or geometric shapes. Then, after letting the infant see the first picture, they show him a new picture and measure how much time the infant spends looking at the new rather than the old picture. On average, an infant will spend 60% of his time looking at the new picture, but there are substantial individual differences. The reason this test is significant, says Plomin, is that "the babies are telling you they recognize the difference between the old picture and the new—that's the key. They are not just discriminating the two. They are showing you that they remember the old picture."

And the reason that Rose and Bornstein think their correlations between this visual recognition in infancy and IQ at age 4 to 6 may be significant is that they believe they may be picking up mental processes in infancy that are important to learning and thinking in general. "We doubt that what we are seeing is the continuity of visual recognition memory per se," Rose remarked. "Clearly, we think we're into information processing, into capturing how the organism deals with information. Dealing with novelty is what life is all about." So it is not the correlation but the link to the thinking process that is intriguing. "If we had found that toe length was correlated with later IQ, I would not be very interested," Rose said.

Bornstein agrees. "These particular measures represent a way to access the human mind," he says. "First we bore you with stimulus A and then we show you stimulus B. Is it different? How early do you recognize it?"

The findings that visual recognition tests predict, to some degree, intelligence means that psychologists at least have hope of finding a way to focus their efforts to give children who will have academic difficulties extra help early on. But now it is up to the researchers to find good ways to help the children who need it most. ■

GINA KOLATA

Social Life: A Question of Costs and Benefits

Many mammals live in groups and are therefore social to some degree or another. The structure of social groups can, however, be very different between different species: some groups are made up of adults of both sexes, others are sexually segregated; in some groups the adult females are related to each other, in others the males are kin. And so on. The nature of the social structure—or lack of it—in any particular case was once thought to be an inbuilt characteristic of the species, but it is now seen as much more a behavioral response to a multitude of factors in the environment, and these include the type and distribution of food resources, climate, and, of course, other individuals. Socioecology is a way of looking for patterns in social behavior among different species as they relate to the entire range of internal and external influences to which individuals are exposed. A recent meeting in Durham, England, addressed these issues, a sample of which is presented here.*

The Multiple Benefits of Babysitting Duties

Many mammals live in groups for one or more of a spectrum of reasons, which may include the very practical benefits of protection against predation and the optimization of protecting and gathering food resources. Once a species adopts group living the individuals within the group necessarily become social to some degree, and this affords the opportunity for individuals to help each other, a key area of which is in the rearing of young. Phyllis Lee of the University of Cambridge, England, described the extent to which vervet monkey and elephant mothers might benefit from communal care in the rearing of offspring.

Although various aspects of communal care are quite common among mammals—a recent review of the subject listed 120 species in which such behavior has been observed—the full range of caring activities occurs in only a few species. "A common theme amongst these species," notes Lee, "is that they live in small, stable groups of familiar individuals and typically the groups are composed of kin of varying degrees of relatedness."

Related individuals will clearly have a vested genetic interest in ensuring the survival of each others' offspring, as long as the group does not reach a size at which competition for limited resources becomes critical. In fact, the network of helpers within a group can become quite complex, but this depends on the precise social structure—in terms of numbers of adult males to females, for instance—within the group. The nature of the social structure will depend on the species involved and the ecological conditions in which its members find themselves.

Vervet monkeys and elephants are similar in that they live in groups made up of females—and their offspring—who were born in that group: they are known as matrilineal kin groups. The two species differ, however, in that the monkey groups include (unrelated) adult males while the elephant groups do not. The range of potential caretakers is therefore different among the two species.

*"Comparative Socioecology of Animals and Humans," University of Durham, 13 to 16 April.

In joint studies with Cynthia Moss in Amboseli National Park, Kenya, Lee showed that the most vulnerable period for young elephants is the first 2 years of life. That communal caretaking can be important is demonstrated by the observation that "survivorship of infants [in this period] can be positively related to the number of potential allomothers (i.e. immature females) within the family unit," says Lee. For instance, infant mortality can be halved, from greater than 30% to about 15%, in family groups that have more than four potential caretakers as against groups with none.

The nature of this caretaking is revealed by the observation that, when a natural mother moves some distance from her infant, allomothers are about twice as vigilant for its safety and five times as responsive to any distress than would be predicted for an "average" group member. By contrast, infants play mostly with their peers, not their potential protectors.

"Elephant family units appear to act as a defensive unit for protecting and caring for young, vulnerable calves," concludes Lee. The chances of a calf's survival therefore seem to be boosted by its relatives' attentiveness, as is its mother's freedom to browse more effectively to meet the energy demands of lactation. But whether alloparenting can actually shorten the interval an adult female has between births—which would enhance her reproductive success—has yet to be demonstrated, notes Lee.

Infant mortality is also a major factor in the lifetime reproductive success of female vervets, and so any help a mother receives when her infant is in its vulnerable early months will be extremely important. As with elephants, it turns out in vervets that close kin are especially vigilant of infants, but the network of interactions is more complex and involves mature males. Lee also observed that "infants of high dominance mothers were contacted and cared for more frequently than those of lower dominance." But infants born early in the season were the center of a lot of attention, whatever their dominance rank.

"The contribution of allomothers to reproductive effort," notes Lee, "is potentially greatest when they provide direct protection for infants, and when they reduce maternal foraging costs, thus allowing mothers to maintain infant growth and again increasing the probability of infant survival."

Mothers clearly benefit if caretakers improve the chances of survival of their offspring. But immature caretakers benefit too, not least by learning parenting techniques. The network of benefits is therefore wide and potentially strong. An interesting question is, Can the benefits of communal care be powerful enough to encourage sociality in the first place, and not just be a bonus that flows from it?

Babies at play. *Young elephants play with their peers but are cared for by relatives.*

The idea is seldom contemplated for mammals, though in some bird species it does seem to be the case. Lee doubts that the benefits of communal care are powerful enough on their own to be the cause of sociality in mammals. Once sociality has developed for other reasons, however, the nature of the social group might be influenced by the advantages gained from communal care: specifically, small, stable, matrilineal groups would be favored.

Why Is Ape Tool Use So Confusing?

Technology was once thought to be a uniquely human attribute, but the discovery of tool use in apes, otters, birds, and even wasps has scotched that convenient rubicon. Nevertheless, the extent and nature of tool use among apes remains a subject of considerable importance in relation to the development of technology among the earliest members of the human family, the hominids. William McGrew of Stirling University, Scotland, therefore decided to survey what has been observed among our simian cousins, and declared himself to be "genuinely puzzled" by what he found.

"For most of my career I've worked with chimpanzees," he said, "and I have tended to generalize from chimps to other apes. Great apes have usually been considered to be of similar intelligence, and I expected similarities in tool use to what I had known about chimps." Wrong. Although the data are still somewhat spotty, it is clear that there are some real paradoxes.

For instance, the most adept and inventive simian tool user in captivity is the orangutan, one individual of which has been known to use a hammerstone with which to make a stone flake that was used to cut string around a box containing food. No chimp has been seen to use a tool to make a tool in this manner. And yet orangs have never been observed to use tools in the wild, uninfluenced by humans. Gorillas, which are closely related to humans and chimps, have only infrequently been seen to use tools in captivity, and never in the wild.

Apart from the chimpanzee, which uses tools in captivity and in the wild, whether or not there is any human intervention, "how an organism behaves in captivity may or may not reflect its actions in nature," McGrew concludes overall. However, he says, "it is clear that context is important."

McGrew's aim was first to compile a profile of how each of the apes is known to use tools, and determine what correlations—if any—there were with degrees of relatedness with humans, degree of terrestriality, and type of diet.

On the top of the scale of tool users, as expected, comes the chimp, followed closely by the orangutan (whose record is spoiled only by the total absence of spontaneous tool use in the wild). The pygmy chimpanzee lies some way behind in third position, being a competent spontaneous tool user in captivity but so far has failed to perform in the wild (in sight of an observer, that is), whether spontaneously or influenced by humans. Highland and lowland gorillas, in company with gibbons, make a motley last place, each of which has just occasionally used tools spontaneously in captivity but never spontaneously in the wild. Gibbons have been known to hurl branches at human observers standing at the bottom of the apes' tree, but that isn't thought to count for very much.

So, what of potential evolutionary and ecological correlations? "If you'd expected to see degree of relatedness to humans correlate with degree of tool use, you'd be disappointed," concludes McGrew. Although the chimpanzee is in the right position on the lists—top in both tool use and relatedness—the orangutan immediately throws the correlation awry. Apart from the gibbon, the orang is genetically the most distant of all the apes to humans, and yet it is number two in the tool-using charts. Gorillas, which are just about as close genetically to humans as are chimpanzees, are about as poor at using tools as are gibbons.

Going from phylogeny to socioecology, says McGrew, "the results range from the puzzling to the perverse." It is worth noting that the earliest tool-using hominids appear to have been highly terrestrial, albeit with some arboreal abilities. However, as far as degree of terrestriality is concerned, the living ape species least adept at using tools find themselves at the two extremes of this

measure: they are the totally terrestrial gorilla and the exuberantly arboreal gibbon. Exit another potential predictor.

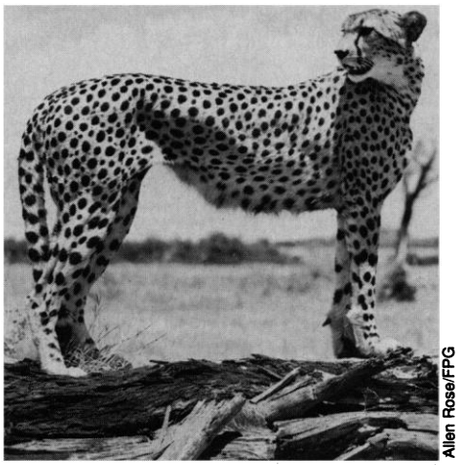
McGrew sees no obvious correlation between type of social structure and tool use, nor with type of plant foods—fruit versus leaves—most exploited in the diet. "But for animal foods," observes McGrew, "a striking correlation appears: the more animals are eaten, the more tool use." What this means is not clear, however, because only chimpanzees use tools—pieces of tree limbs—in getting their prey.

Not surprisingly, McGrew titled his talk "Why is ape tool use so confusing?" Nevertheless, he says it is clear that "all great apes are smart enough to use tools, but they only do so in useful circumstances." Given this baseline, says McGrew, one model of an "ancestral proto-pongid could have had the intellectual capacities of living great apes and its tool use might have been more or less developed in local circumstances according to some as yet undetermined combination of socioecological forces." This ancestral ape would have been a behavioral mix of chimps, gorillas, and orangs. The latter two have given up tool use in the wild, he suggests, because of a commitment to an arboreal life in one case (orangutan) and a move to "life in the 'salad bowl' in the other."

Why Isn't a Leopard More Like a Lion?

The image of a pride of lions living and hunting cooperatively on the African plains is so arresting that it tends to make one think of hunting and social cooperation as a natural partnership in carnivorous life. In fact, of the 37 species in the cat (felid) family, the lion is the only one that is social, with males and females living together. The rest are distinctly asocial, with the single exception of cheetahs, in which males occasionally live in small, all male groups.

Carnivores can benefit from group living in several ways, and these include detection of predators, defense of carcasses against other carnivores, and the reduction of risk of injury in the pursuit of prey. In the face of these potential benefits, why then are the great majority of cats asocial? "Sociality in felids is limited by the costs rather than the benefits," concludes Tim Caro of the University of Michigan. There is no doubt that the benefits of sociality are there to be had, he says, but in becoming social most cat species would simply incur more costs than they would reap benefits. These costs, which until now have not been carefully examined, have to do mainly with the ability to provide



Allen Rose/FPG

Hunter on watch. *The costs of hunting make female cheetahs into lone predators.*

sufficient food for a large group of individuals.

A male's reproductive success is determined by his access to mature females. How social males of a particular species are therefore depends on the distribution of potential mates. Female lions live in prides of between 2 and 18 related individuals, together with their offspring. It therefore makes sense for a male lion to live with the pride, because he will have access to a potentially large number of mates.

It makes even better sense, however, if the male shares the pride with several other males—usually brothers—because a group of males can more effectively defend the genetic interests at stake in the group. "The costs of sharing matings are outweighed by the ability of coalitions to monopolize large numbers of females," notes Caro.

The same applies to male cheetahs, but for different reasons and with different consequences. Excluding the cubs that live with them, female cheetahs are completely asocial. They make a living in very large home ranges—in the order of 800 square kilometers in the Serengeti, for instance—because they follow the migratory habits of their favorite prey, Thomson's gazelle. However, they are not territorial—and indeed would not be able to cover so large an area—and often share sections of their hunting range with several other females at any one time.

This relative concentration of females is apparently sufficient to make it worthwhile for several males to join forces to defend these loose aggregations against other males, again so as to monopolize mating opportunities. The males therefore live in small coalitions, but as the females do not live in groups, there is no equivalent social unit to the pride of lions.

For the great majority of the cat family, however, these conditions do not apply and so, says Caro, "the most successful reproductive option for males is to remain single and attempt to limit range incursions by all other males."

The principal question, therefore, is why are female felids so asocial? The first point to emphasize, says Caro, is that although the females are asocial, they do not live alone. He has studied cheetahs in detail and has shown that for more than three-quarters of their lives, female cheetahs live in the company of their cubs, which usually number three in the Serengeti population. And for at least half of this time the cubs are big enough and have sufficiently large appetites that the food demands of her litter far exceed her own. Although the cubs learn to hunt with their mother, for the most part they contribute very little to their upkeep. "Cubs appear to be essentially parasitic on adult females for food," says Caro.

By living in larger groups in company with other mothers, female cheetahs would potentially benefit in the way described earlier, but would have to increase the volume of food production. Caro asked what the cost of this increase would be.

In common with most carnivores, cheetahs usually have more failed chases than successful ones. This means that they must spend more time hunting than might otherwise be expected. For instance, a mother with three cubs spends about 40% of her time searching for prey. If an adult lived in the minimum sized social group—two breeding females and their offspring—"mothers would have to search for between 63.4% and 70.0% of the day" in order to satisfy the group's needs, calculates Caro. Given the other caretaking activities the mothers must perform, this would leave just 7.5 minutes "free time" in each hour, which, says Caro, "might be risky in terms of securing prey, energetic costs aside."

Going for bigger prey than the favored Thomson's gazelle, which weigh about 80% of the adult cheetah's body weight, might be a potentially rewarding strategy. However, success rates of each hunt declines as prey size increases—from 50% at 10 kilograms to 20% at 30 kilograms—and this is not much improved by cooperative hunting, if observations on coalitions of male cheetahs is anything to go by.

Because of the constraints under which females cheetahs currently hunt, in order to substantially increase their productivity they would need to be able to exploit larger prey that are easy to catch. Such prey either do not exist or are very scarce, concludes Caro. Nor is this option available to most felids, he says, with the exception of lions. Lions can hunt large prey, and therefore can be social. But for the rest of the cats, the costs of hunting keeps them asocial. ■

ROGER LEWIN