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Chimpanzee and Human Intelligence

Life History, Diet, and the Mind

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Compared to our close living relative, the chimpanzee, humans have at least five distinctive life-history and behavior characteristics: (1) an exceptionally long lifespan; (2) an extended period of juvenile dependence and learning; (3) a pattern of food sharing, particularly between the sexes and from older to younger; (4) male support of reproduction through the provisioning of females and their offspring; and (5) a unique feeding niche based on food-sharing that exploits high-quality, difficult-to-acquire resources. This suite of characteristics is associated with a large brain and the psychological attributes of increased cognitive capacity and insight acquired through an extended period of learning and development.

These extraordinarily distinctive features are such that everywhere humans live, they are at the very top of the food hierarchy, whereas our close relatives live in highly restricted distributions and are nearing extinction. Nevertheless, there is so much shared history, biology, and behavior between humans and chimpanzees that it is often proposed that we can see and better understand ourselves by understanding them. The mapping of the chimpanzee genome suggests that we differ by approximately 1% of the functional genome, and that the separation of the two species is only 5 to 7 million years ago (Chimpanzee Sequencing and Analysis Consortium, 2005). Chimpanzee cognitive capacities and social behavior are also striking in their high levels of socially transmitted behavior, patterns of food procurement that include extractive foraging and the hunting and social exchange of meat, fission–fusion male-bonded social systems, similar patterns of social alliances and conflict resolution, and cognitive behaviors that suggest both a concept of the minds of others and quantitative representation. This impressive display of commonalities leads one to ask whether the differences between the two species are largely matters of degree. Conversely, when we explore the parameters of the two species' life courses, their feeding niches, and intelligent performances, we find major distinctions that set humans far apart.

CHIMPANZEE CULTURE, BEHAVIOR, AND COGNITION

The recognition and identification of socially transmitted, locally variable, adaptive behavior patterns among chimpanzees have been the focus of numerous recent books and publications (Boesch, Hohmann, & Marchant, 2002; McGrew, 2005; McGrew, Marchant, & Nishida, 1996). It is clear that chimpanzees use socially transmitted behavior patterns to solve many critical evolutionary challenges, such as finding food, acquiring mates, forming social alliances, and raising young. Furthermore, studies in captivity indicate that chimpanzee cognition and intelligence may combine features of learning processes, self-awareness, and ability to communicate, which are critical underpinnings to human culture. We also see striking continuities in diet, including food sharing, hunting, and tool use.

The foundation of the chimpanzee diet is collected plant parts and animals. Chimpanzees are notable for two features that link them to humans (Byrne, 1995). The first is their use of extractive foraging techniques and the hunting of meat. These behaviors involve acquisition of skilled performances during development, as well as variability from one study locale to the next. The second is their use of tools as aids to extractive foraging. Tool use has been well described at all the major study sites for chimpanzees. It includes sponging, fishing, probing, digging, and bashing behaviors, all of which give chimpanzees access to resources that are not accessible or are inefficiently extracted by bare hand. Although the calories gained from extractive foraging and hunting form a relatively small percentage of their total diet, this aspect of chimpanzee behavior indicates an interest in hard-to-acquire foods and is expressed in ecologically diverse habitats (Lancaster, Kaplan, Hill, & Hurtado, 2000).

Another feature of chimpanzee behavior that has attracted the attention of evolutionary socioecologists is their pattern of group formation, which is unusual among nonhuman primates (Boesch et al., 2002; McGrew et al., 1996). Chimpanzee social organization is characterized by male philopatry, female migration at puberty, bonding between male relatives, and the collaboration of bonded males in hunting and in the defense of resident females against other male-bonded groups. This complex is shared with humans, another species characterized by male bonding and collaboration for aggression and defense. The alliances formed by chimpanzees for the purpose of gaining and defending mates, social status, and feeding territories are supported by a repertoire of behaviors also shared with humans. Researchers have described social alliances and conflict resolution through reciprocity, retaliation when favors are not returned, reconciliation, and a form of negotiation through conflictive interactions. Even more interesting, field researchers have described chimpanzee adult males' use of hunted meat as a medium of social exchange for access to both sex and allies. Food sharing is such a critical feature of the human adaptive pattern, in which adults feed young, and men and women share collected and hunted foods, that any food sharing in chimpanzees arouses great interest in the scientific community. So far, food sharing has been reported for chimpanzee mothers to offspring for hard-to-process foods, for males to female partners for sex, and for possessors of meat to social allies and close kin, all of which are identifiable as typically human sharing behaviors.

The question of chimpanzee intelligence, cognitive abilities, the mode of transmission from one generation to the next of locally variable and adaptive behavior patterns, and the extent to which chimpanzees can interpret the behavior and understand the thinking processes of other chimpanzees can only be investigated fully in captivity (Bering & Povinelli, 2003; Byrne, 1995; Maestripieri, 2003; Povinelli, 2003). Byrne (1995) argues that great apes and humans stand apart from other primates in their ability to acquire novel behavior patterns through imitation—a quick way of acquiring a complex skill and, at the same time, avoiding time-consuming and potentially dangerous errors. The ability to imitate is especially significant for a species that depends on skills-based performances for extractive foraging and hunting. The intelligence of chimpanzee behavior in the laboratory also suggests a theory of the mind, the ability to manipulate numbers, and the use and manipulation of symbols (Maestripieri, 2003).

Bering and Povinelli (2003), however, argue that similarities in behavior such as the use of symbols can be very deceptive. They note that humans as a species attribute their own emotions, desires, thoughts, and feelings to a dramatic range of animals, plants, and even objects. This means that we are willing to attribute mental states to chimpanzees and to assume that chimpanzees will do the same about us. Although humans and chimpanzees can be profoundly similar in their spontaneous, everyday behavioral interactions, they can still be radically different in their interpretation of such behavior. Bering and Povinelli argue for a profound divide between human and chimpanzee cognition, a gap based on the unique human ability to form concepts about purely abstract things that cannot be directly observed. They describe them as concepts about causation in the "hidden" world—the world of forces and causes that lie behind the surface appearance of things, such as others' emotions, perceptions, and beliefs, or the forces impinging on inanimate objects, such as gravity, force, mass, and physical connection. Povinelli's (2003) experimental research on captive chimpanzees reveals that behaviors that appear to represent insight into causation are really quick studies, that is, the ability to link cause and effect without any insight into their actual relation.

Research on chimpanzee behavior in both the wild and captivity during the past 50 years provides ample evidence of commonalities between humans and chimpanzees in extractive foraging and hunting, social learning and intergenerational transmission of complex behaviors, social organization, behavioral patterns of social affiliation and conflict, and details of intelligence and cognition. The question remains as to whether there is evidence that these considerable commonalities in behavior have had the same impact on the life histories of the two species or on the configuration of the feeding niches they occupy, or whether they are even based on the same cognitive mechanisms.

LIFE HISTORIES OF WILD CHIMPANZEES AND HUMAN FORAGERS

Although both chimpanzees and humans are large-bodied, long-lived mammals, there are major differences in five critical parameters of their life history: survivorship to age of first reproduction, life expectancy at the beginning of the reproductive period, absolute and relative length of the postreproductive period, spacing between births of surviving offspring, and growth during the juvenile period (Kaplan, Hill, Lancaster, & Hurtado, 2000). Human and chimpanzee life-history parameters based on data from extant groups of hunter-gatherers and chimpanzees indicate that forager children experience higher survival to age 15 (60 vs. 35%) and higher growth rates during the first 5 years of life (2.6 vs. 1.6 kg/year). Chimpanzees, however, grow faster between ages 5 and 10, both in absolute and proportional weight gain. The early high weight gain in humans may be the result of the earlier weaning age (2.5 vs. 5 years), followed by provisioning of highly processed and nutritious foods.

The chimpanzee juvenile period is shorter than that for humans, with age at first birth of chimpanzee females about 5 years earlier than is true of forager women. This is followed by a dramatically shorter adult lifespan for chimpanzees. At age 15, chimpanzee life expectancy is an additional 15 years, whereas foragers can expect to live an additional 38 years, if they have survived to age 15. Importantly, women spend more than one-third of adult life in a postreproductive phase, whereas few chimpanzee females spend any postreproductive time. The overall survival probabilities and lifespan of the two species are striking: Less than 10% of chimpanzees born survive to age 40, but more than 15% of foragers survive to age 70!

Finally, despite the facts that human juvenile and adolescent periods last longer and human infants are larger than infant chimpanzees at birth, forager women are characterized by higher fertility. The mean interbirth interval between offspring when the first one survives to the birth of the second one is 1.62 times longer among wild chimpanzees than among modern forager populations.

To summarize, human foragers show a juvenile period 1.4 times longer and a mean adult lifespan 2.5 times longer than that of chimpanzees. Humans also experience higher survival at all postweaning ages, but slower growth rates during midchildhood. And despite a long juvenile period, slower growth, and a long postreproductive lifespan, forager women achieve higher fertility than do chimpanzees.

CONSUMPTION AND PRODUCTIVITY THROUGH THE LIFE COURSE

The diets of foraging societies and chimpanzee communities demonstrate overlap in component categories but wide differences in relative composition (Kaplan et al., 2000). For example, hunted meat makes up about 2% of the chimpanzee diet but almost 60% of the forager diet. Chimpanzees rely on collected foods for 94% of their nutrition, especially ripe fruits. Such foods are nutritious, but they are neither hard to acquire nor learning-intensive. Humans, in contrast, depend on extracted or hunted foods for 91% of their diet. The data suggest that humans specialize in rare but nutrient-dense resources (e.g., meat, roots, nuts), whereas chimpanzees specialize in ripe fruit and fibrous plant parts. These fundamental differences in diet are reflected in gut morphology and food passage times, in which chimpanzees experience rapid passage of bulky, fibrous meals processed in the large intestine, whereas humans process nutritionally dense, lower volume meals that are more amenable to slow digestion in the small intestine.

Figure 11.1 presents the survivorship and net food production through the life course of humans and chimpanzees (Kaplan et al., 2000). Humans consume more than they produce for the first one-third of their life course. In contrast, chimpanzees are self-supporting by the age of 5. Thus, human juveniles, unlike chimpanzee juveniles, have an evolutionary history of dependency on adults to provide their daily energy needs. Furthermore, over one-half of chimpanzees are already dead by the age of independent feeding, whereas humans do not reach the 50% loss mark until they are over 30. Even more striking is the steady increase in productivity over consumption among humans into their 30s and early 40s. Further data also indicates that forager women take much longer than men to reach peak productivity. For-

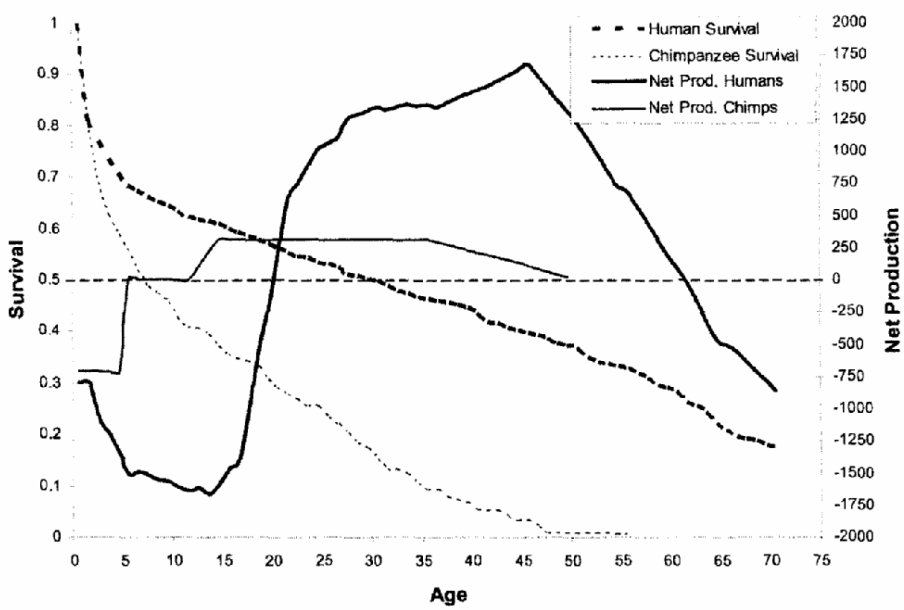

FIGURE 11.1. Net food production and survival: human foragers and chimpanzees. Based on Kaplan and Lancaster (2003).

ager males produce more than they consume in their late teens, but their peak productivity builds slowly from their early 20s and 30s, then is sustained for 20 or more years at a level of approximately 6,500 kcal per day. In contrast, forager women consume more than they produce until menopause. The provisioning of reproductive women and children has a powerful effect on the production of children by reducing the energy cost and health risk of lactation to the mother, and by lifting the burden of self-feeding from the juvenile. This permits a shortened interbirth interval without an increase in juvenile mortality.

The human adaptation is both broad and flexible in one sense, and narrow and specialized in another. It is broad in the sense that, as foragers, humans have existed successfully in virtually all of the world's major habitats. It is narrow and specialized in that it is based on a diet composed of nutrient-dense, difficult-to-acquire foods and a life history with a long, slow development, a strong commitment to learning and intelligence, and an age–profile of production shifted toward older ages. To achieve this diet, humans are very unproductive as children, have very costly brains, are extremely productive as adults, and engage in extensive food sharing, both within and between different ages and sexes.

CONCLUSION

Comparisons between humans and chimpanzees are productive when based on detailed scientific insight into the adaptations of the two species. Chimpanzees are not just close relatives. Their behavior and biology have also been researched during the past 100 years in numerous laboratories and field locations. Chimpanzees are probably the best-studied nonhuman species in the wild considering both the number of research sites and the extraordinary time–depth of extant data bases, some of which are approaching 50 years. The similarities between the two species are striking and evoke empathy in humans because of a common identity. However, careful scientific comparisons reveal a surprisingly vast gulf, suggesting that we may learn more about the two species and the niches they occupy by concentrating on their comparative differences. Life-history and dietary parameters reveal that the human line moved into a unique niche based on major changes in diet, with attendant shifts in reproduction, growth, length of life, survivorship, and social behavior. Furthermore, research into the actual cognitive mechanisms underlying behavioral parallels between the two species suggests that chimpanzees have little insight into their behavioral choices and are content with knowing what works, not why it does so. In contrast, the human mind focuses on the "unseen" world of causation, and beginning in the first year of life asks questions about why and how.

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