papers concern the full quantum theory of gravity. In fact a satisfactory theory of this kind does not yet exist, partly because when gravity is coupled to matter the usual quantization procedures lead to a nonrenormalizable theory. B. S. DeWitt reviews the present status of these problems, and Hawking and S. Weinberg offer accounts of their own proposals for solving them (Hawking using path integrals in a space-time with positive-definite metric, which he believes may be dominated by gravitational instantons, and Weinberg using renormalization group arguments in terms of which he proposes that the requirement of renormalizability may be adequately replaced by a weaker one of asymptotic safety).

The book is remarkably varied and the papers are of a consistently high quality and interest. Indeed, in their power and comprehensiveness they constitute a unique monument to the genius of Einstein, and, may I add, to the brilliant and profound work of the contemporary generation of relativists, many of whom are at once the creators of the present state of the subject and, in the pages of this marvelous book, its masterly expositors.

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Zooarcheology

Reindeer and Caribou Hunters. An Archaeological Study. ARTHUR E. SPIESS. Academic Press, New York, 1979. xiv, 314 pp., illus. $25. Studies in Archaeology.

No species evokes clearer images of windswept northern wastes than *Rangifer tarandus*, known popularly as the reindeer in Eurasia and as the caribou in North America. Over most of its arctic and subarctic range, this species is by far the most common large mammal and therefore a prime source of meat and skins for indigenous peoples. Anthropological interest in the relationship between these animals and people dependent on them is especially great because during Pleistocene glacial intervals the species extended its range far southward and was widely preyed upon by Paleolithic hunters in mid-latitude Eurasia.

Spiess has brought together a great deal of information on the distribution and ecology of recently observed reindeer/caribou and on the social organization and technology of the people who hunted and, in some cases in Eurasia, also herded them. He emphasizes that people exploiting these animals must be responsive to marked seasonal changes in the composition and distribution of the animals' social groupings. For archeologists, the seasonally changing age-sex composition of these groupings, combined with the fact that the great majority of the calves are born at more or less the same time (usually within a two-week period between mid-May and mid-June, depending on the place), means that the age-sex profile of the animals represented in a site can be used to establish the season when people were at the site, as well perhaps as the purpose for which (for meat or skins) and the methods by which people obtained the animals. These methods could range from selective stalking of individual animals to driving of whole groups into corrals or other traps.

Spiess shows that some previous attempts to determine the age and sex of archeological reindeer used methods of questionable accuracy or reliability, whereas the methods he employs have a high probability of providing meaningful results. To demonstrate the interpretative potential of caribou age-sex profiles from archeological bone assemblages, he uses his analyses of bones from various protohistoric North American sites to show that there is a reasonable fit between the human behavior inferred from the bones and behavior that could have been predicted from historic observations. He then undertakes the more ambitious task of drawing similar inferences from a Paleolithic reindeer sample, where of course no ethnohistoric check is possible. The Paleolithic sample was derived from layers dated between roughly 35,000 and 18,000 years ago ("early Upper Paleolithic") at the Abri Pataud in southwestern France, meticulously excavated over many years by Hallam L. Movius.

The most interesting and important inference that Spiess draws from his study of the Pataud materials is that people occupied the site between late fall and early spring. This appears to be true for the entire 17,000 years of occupation, although changes in artifacts indicate that the people who brought reindeer bones to the site at different times belonged to very different cultures.

Spiess's writing is very loose, and the presentation could have been substantially improved by greatly reducing the amount of detail about the recently observed hunters and replacing it with relevant background material on Paleolithic archeology and the place of the Abri Pataud in prehistory. Still, Spiess's work is a valuable contribution to archeology because it illustrates as clearly as any study to date the information about human behavior that can be obtained from careful determination of the ages and sexes of animals represented in ancient archeological sites. All that is necessary for this kind of study to burgeon now is the kind of thoughtful selection of sexing and aging methods exemplified in Spiess's work and the careful excavation of large bone samples, comparable in size and quality to the samples obtained by Movius at the Abri Pataud.

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Primate Behavior

The Great Apes. DAVID A. HAMBURG and ELIZABETH R. MCCOWN, Eds. Benjamin/Cummings, Menlo Park, Calif., 1979. xiv, 554 pp., illus. $18.95. Perspectives on Human Evolution, vol. 5; a publication of the Society for the Study of Human Evolution, Inc.

Long awaited and already widely cited, this volume consists of papers presented at a 1974 Burg Wartenstein conference, plus a few papers added later. The majority of the papers describe long-term, systematic field observations of gorillas, orangutans, and chimpanzees carried out under difficult conditions. Care was also taken to provide some representation of laboratory and theoretical perspectives, and there are several fine essays on communication and a detailed theoretical paper on aggressive competition in animals generally. No comparable body of reliable information about the natural history of great apes exists. Thus, the book suffers relatively little from its late publication, although an updated summary chapter would have been valuable.

The extraordinary biochemical similarities between humans and the terrestrial African apes (gorillas and chimpanzees) that have been investigated through DNA hybridization, protein sequencing, and immunological analysis will be well known to readers of *Science*. Less well known may be some of the recent findings that challenge old ideas about the behavioral differences that separate humans from other primates. This volume documents for other hominoids intercommunity killings, avoidance of inbreeding through female emigration (in two of the three great apes), face-to-face copulation and elaborate sexual foreplay (among wild orangutans;

previously reported only in captivity), and sufficient intelligence to be taught to communicate with symbols and to suffer from some fairly complicated "neuroses" in captivity.

Two papers are devoted to gorillas. Fossey details the first 36 months of development among wild gorillas born near the Virunga volcanoes of Rwanda and Zaire, and Harcourt outlines social relations among adult gorillas living in cohesive male-oriented groups. Harcourt's sketch is much less complete than his subsequent publications analyzing the process of female emigration. Female gorillas transfer out of their natal groups about the time of maturity to join either a lone male or another group. Some females transfer several times. Such transfers appear to be influenced by range quality, characteristics of the male, and success of the female in rearing offspring.

Three papers on orangutans reveal general agreement among Rodman, MacKinnon, and Galdikas, researchers from diverse backgrounds working in different areas of Borneo and Sumatra. Adult male orangutans are much larger than females (about one quarter again as big), and these solitary titans traverse large areas encompassing the home ranges of several mother-offspring units. Subadult males may periodically join and travel with females and may even attempt forcibly to copulate with them, but females appear to prefer older males.

Over half the book (13 of 22 papers) concerns chimpanzees. A paper by Kano describes his pilot study of the least known of all apes, the pygmy chimpanzee (*Pan paniscus*) of central Africa. The remaining papers focus on the common chimpanzee (*P. troglodytes*). Populations of chimpanzees have been monitored by Goodall and her associates at Gombe since 1960 and by Japanese researchers in the nearby Mahale mountains of western Tanzania since 1965. As was first suggested by Itani and Nishida, chimpanzees live in permanent communities. Nishida and Pusey describe in depth the temporary and permanent transfers between communities by young females, typically nulliparous females in estrus. Drawing on information from both sites, Wrangham proposes a model to account for what had previously seemed to be a completely fluid social structure. Female chimpanzees, like female orangs, are distributed individually according to foraging needs. Again, the social system is adapted to female distribution. Community boundaries are determined by the activities of bands of males (presumed to be close relatives) who patrol the boundaries. Goodall and her associates provide detailed accounts of these boundary "patrols" and of the aggressive interactions that ensue when members of neighboring communities meet. Although chiefly composed of males, bands on patrol may be accompanied by one or more females, usually females in estrus.

> Chimpanzees taking part in patrols tended to travel in close, compact groups. Travel was silent with frequent pauses to look and listen. Often an individual stood bipedally, to see over tall grass or stare down into a ravine ahead . . . sometimes they climbed into a tree. . . . During patrols, males (rarely females) sometimes intently smelled the ground and the vegetation. They also smelled discarded food wadges and feces [p. 25].

When detected, individuals from other communities are pursued and attacked with "extreme violence and a brutality shocking to observers" (p. 35). Gang beatings, sometimes lasting ten to twenty minutes, left victims severely, sometimes fatally, injured.

For anthropologists who like to emphasize the difference between humans and other primates, McGrew's analysis of sex differences in mode of food acquisition will be even more provocative. At Gombe there is a significant difference in the animal-prey intake of males and females. Males consume more meat from birds and mammals, females more insects. Although sex differences in foraging habits are not really all that unusual among animals, McGrew (pp. 449-450) stresses the point that

> Male chimpanzees obtain meat by stalking, pursuing, capturing, killing, dividing, and distributing a single mammalian prey. This behavior often involves primarily male groups roaming relatively great distances and acting cooperatively when the appropriate situation fortuitously arises—in short, *hunting*.

On the other hand

> Female chimpanzees . . . obtain ants and termites by prolonged, systematic, and repetitive manipulative sequences. Several chimpanzees may work side by side, but basically the activity consists of an individual accumulating a meal of many small units that are usually concentrated at a few known permanent sources—in short, *gathering*.

"Anting behavior—two females and two males fishing for arboreal ants with peeled bark." [From *The Great Apes*]

Deliberate choice of the terms "hunter" and "gatherer," as well as more casual statements scattered through the book in chapters on behavioral disorders, learning, and aggression, derive from the assumption on the part of some of the authors that there is considerable continuity between the experiences of other apes (especially chimpanzees) and humans. This is a controversial perspective, not explicitly dealt with in the book. Nevertheless, scientists unfamiliar with the behavioral research reported in this volume may find that it radically alters the way they view our nearest nonhuman relations.

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Developmental Psychology

The Ecology of Human Development. Experiments by Nature and Design. URIE BRONFENBRENNER. Harvard University Press, Cambridge, Mass., 1979. xviii, 330 pp. $16.50.

In this book Urie Bronfenbrenner has set down the point of view he has been developing and presenting in numerous papers and talks over the last several years. This point of view includes a specific conception of what is acceptable research in developmental psychology, a characterization of the expanding network of factors that influence development, and the assertion that social policy variations provide natural experiments that can provide important information about developmental laws.

Bronfenbrenner begins by proposing a "new theoretical perspective" for developmental psychology, though he acknowledges it as derivative from the work of George Herbert Mead, Kurt Lewin, and others. This perspective is that the environment of the individual being studied must be taken into account if the behavior of the individual is to be interpretable. The dynamics of that environment, it is claimed, have significant influence on behavior; development does not occur in a vacuum and must be studied "in context." Although basic processes of perception, learning, and motivation are important, they are subsidiary factors in Bronfenbrenner's view of development, which he defines as "the person's evolving conception of the ecological environment, and his relation to it, as well as the person's growing capacity to discover, sustain, or alter its properties" (p. 9). According to Bronfenbrenner, the failure of developmental psychologists to understand or document the effects of environmental variables has hampered understanding of human development.

Bronfenbrenner believes that the unique aspect of human behavior is that humans fill every setting with "social meaning" and the social meaning attributed in turn influences the behavior being observed in the setting. Without knowledge of the social meaning of the setting as it exists for the individual, any other observations of the individual's behavior will be uninterpretable and, from Bronfenbrenner's point of view, invalid. Thus, the well-controlled laboratory setting into which children are brought for purposes of research cannot produce valid data on perception or cognition if the experimenter does not know what social meaning the child has attributed to the laboratory and has not documented the child's attributions. The older the individual the more factors there are that determine social meaning, including increasing numbers that are not immediately present. Because social meaning has typically not been assessed in the controlled laboratory setting, successful generalizations from laboratory to natural environments have been rare. In addition, developmental psychologists, according to Bronfenbrenner, have not been particularly imaginative about making use of the natural experiments provided by normal variations of the natural environment.

Research conducted in the natural environment does not, Bronfenbrenner asserts, automatically acquire ecological validity; nor is it impossible for a laboratory study to be ecologically valid. In either case ecological validity depends on whether the investigator has assessed the meaning of the environment from the subject's point of view. In this sense Bronfenbrenner uses the term ecological validity as phenomenological validity. For research to be valid as developmental research, it must take into account the phenomenological aspects of the environment, it must involve data collected at more than one point in time (preferably with the same subjects), and it must be addressed to questions of cross-context effects and relationships.

Bronfenbrenner offers a new set of systems that he believes both organize the factors influencing development and capture the complexity of the variables that must be accounted for in research on development. They are the microsystem, interpersonal interactions in a single setting; the mesosystem, the interrelationships among two or more settings; the exosystem, effects on individual development of settings that do not include the individual; and the macrosystem, subcultural and cultural variables and belief systems.

An extensive case is made for the claim that implementations of new social policies can affect one or more of the systems and thus provide natural opportunities to observe developmental laws. For example, preschool intervention programs make it possible to study the young child in different microsystems, offer unique mesosystem observations, permit the study of effects of exosystem relationships that would not exist if the intervention programs had not occurred, and introduce changes in the macrosystem. Thus, the traditional notion that social policy follows the discovery of facts about development is turned around to the rather unorthodox point of view that developmental psychology needs social policy more than social policy needs developmental psychology.

After stating his basic theses, Bronfenbrenner provides a number of propositions and hypotheses as necessary consequences. None is particularly new to anyone who has been thoughtful about how complex is human development. Many of the 50 hypotheses proposed address the central question of what conditions are likely to foster "good development" and affect the developmental course. For example:

> The developmental impact of a dyad increases as a direct function of the level of reciprocity, mutuality of positive feeling, and a gradual shift of balance of power in favor of the developing person [hypothesis 4, p. 59].
>
> Human development is facilitated through interaction with persons who occupy a variety of roles and through participation in an ever-broadening role repertoire [hypothesis 14, p. 104].

In addition to the obvious definitional, value judgment, and measurement problems the hypotheses present, testing the hypotheses requires longitudinal and cross-setting research in addition to the assessment of social meaning at every point of data collection. To do less is not to do developmental research. According to Bronfenbrenner very few research efforts meet all the necessary criteria, though he chooses a number of studies for discussion as approximating the model he believes will be most fruitful. These range from Spitz's research on institutionalized infants and mother separation to the more recent work of Klaus and Kennell on social bonding in infant development; Hetherington's work on the effects of divorce on children and family functioning and Zimbardo's work on the importance of roles are also cited.