Inferences of cognitive abilities in Old World monkeys.
Semiotica **50-**1/2(1984),69-81.
F. D. BURTON

Introduction

My concern is with the nature and content of the existence of nonhuman primates. The question centers on whether or not nonhuman primates, exclusive of the apes, are capable of higher mental processes. While the question is certainly not new, the possibilities of examining it are.

Philosophers have toyed with notions of animal percepts and human concepts, attempting to dichotomize the world of human and 'beast' for historically quasi-religious reasons (see, e.g., the review in Deely 1971), while their musings have evaded an empirical base, they have nevertheless set the boundaries of discussion.

Two major and perhaps interrelated attitudinal changes have taken place over the course of the last century, however: one concerns children, the other nonhuman animals. Whether it is the fallout from research that has caused the change, with the general, popular notions following, or the reverse, is not important. Suffice it to say that we are now in a position to truly observe without conventional prejudice. Children are not merely adults; nonhuman animals are not merely machines. This simple point, although a truism, has not yet been fully assimilated, as perusal of recent literature demonstrates. What we think about the data before us is clearly a matter of opinion. The facts remain the observable phenomena; the opinion enters in from the moment of the choice of which facts to observe, and is sustained through the choice of nature of analysis and ultimately the interpretations given. Our search to be objective is -- at least in social science -- only asymptotically realizable. Quantification, at least in primatology, permits the nimble reconstruction of behavior, although it purports to assess like a hologram, that is, where any piece sampled gives a projection of the whole.

Underlying the central issue is the historical one concerning the relationship between language and cognitive processes. As long as it was assumed, without other options, that language not only mediated but

permitted thought itself, it did have to follow that the communicative behavior of nonhuman animals, including nonhuman primates, was simple programs, the result of selective, evolutionary events. The syllogism followed from the crude but observable fact that animals do not speak, and therefore they could not have language nor could they think. Miller wrote, around the time that Darwin was propounding his great theories, 'The one barrier between brute and man is language.... Language is our rubicon and no brute will dare cross it' (1871; quoted in Passingham 1979).

While a series of scholars invaded this precinct, none is more often cited as the cause for the change in attitude than Piaget. Observations of the mental development of children brought him to the conclusion that thinking occurs outside of language. The basis of logical thinking, it seemed to Piaget, derives from actions; from the knowledge the child abstracts from the objects upon which he acts. Simple abstractions derive from the action itself, rather than from the object acted upon. Action, requiring neither thinking nor any use of expressive language, is both prethought and prelanguage. Piaget's observations on the learning abilities of deaf versus blind children led him to note that blind children, unable to move around as do either normal or deaf children, are delayed in development. Steklis and Raleigh (1979) refer to studies on deaf children and agree that language is separate from thought. Such scholars can conceive of intelligence without language, although not of language without intelligence, as deaf children develop spontaneous sign systems with all the properties of language. Yet the issue remains very much open.

Background

My interest is not in the psycholinguistic debate per se; but only in the effect this opening up of the debate through such work as that of Piaget has had in the study of nonhuman primates.

Full-fledged research on nonhuman primates did not get launched until fairly recently. The spasmodic efforts from the 1920s through the 1940s had brought in their fair share of revelations from such eminent psychologists as Nissen and Kohler. By the 1950s, however, field studies of monkeys were few. Pleas from anthropologists, like Ernst Hooton for example, to widen our comparative base of knowledge of members of the order Primates, went virtually unheeded.

The pioneering efforts of scholars like Zuckerman and above all Carpenter, however, led the way to establishing the field by the early 1960s. Washburn and Devore, in their efforts to describe baboons, did so

within a limited framework of typological thinking. To them, a baboon was 'THE' baboon, and could be generalized even further, to 'THE' monkey. It was not until nearly the end of that decade that the idea of variation in basic structures and patterns of behavior was truly accepted. Variation, where it was not expected, stimulated endless tracts investigating the source for this phenomenon. It is ironic that scholars so well versed in the basic tenets of biology should have been surprised by the phenomenon of variation! Theories invoking ecological determinants vied with genetic ones. At times, synthesis was expected (as in the writings, for example, of Aldrich-Blake), only to be submerged in a new spate of nature versus nurture arguments, in a yet more sophisticated guise. Since 1972, the resurgence of 'nature' is called 'sociobiology', and has come to be the prevailing explanatory device for behavior. The antithesis has made its appearance in the recrudescence of interpretation and its documentation, that what underlies particular acts cannot be explained successfully by recourse only to reproductive facts or ecological factors. The observer's focus telephotos to see the differences and narrows to study the similarities. The level of explanation too often is inappropriate for the level of observation.

The fact that the organism has its individual, ontogenetic history and its group history at the point of birth explains both the similarities it shares with others of its kind and the differences unique to itself.

Social information: Conformities

Field workers have long noticed that each local group of nonhuman primates is remarkable because of certain habits or particular ways of doing things. Endeavoring to restrict himself to terminology that would not be anthropomorphic, the psychologist Hall coined the term 'confermities' to describe the group's way of doing things; its norms or the 'rules and regulations' within a monkey society. Conformities include what monkeys need to know simply in order to live. For example, if one observes the conformities regarding 'food', the basal information would contain 'what to eat'. This information is transmitted to the monkey and absorbed by the monkey infant through olfaction or gustation from food taken out of its mother's mouth. The infant thereby formulates categories of 'edible' and 'nonedible'.

As the infant matures, the category will come to have more members, as the animal enlarges its scope from the physical proximity of its mother to its peer group, and groups of all ages. The young animal observes, imitates, models (Hall 1963), and taste-tests, by which it comes to identify

this basic category; the animal must also learn the conformity of with whom it may eat, and also with whom under what circumstances -- a set of information that is quite taxing, as it varies greatly from situation to situation. The contingencies involved might read: if adult female 1, then eat; if adult female 2, then run unless female 2 is resting, or with an adult male, or being groomed, etc. It is apparent from field observers that information of this sort is constantly being processed. These conformities are socially endowed and socially derived. The quantity of information depends on the individual's ability to store as well as to generate. The pool of group information available also depends upon the number of contributing individuals within the group. It was Carpenter who first examined this in a slightly different vein. He spoke of a 'socionomic index' formulated mathematically as N (N-1)/2. (1964: 219). This demonstrated that the number of relationships were the result of possible dyadic relationships and a function of numbers within the group. 'With the addition of each new individual to a group, the number of specific relations increases by the number already in the group....within the group, each individual has an effective and distinct relationship with every other individual' (Carpenter 1964: 219).

The information reposing in 25 individuals is probably greater than that contained in only five, and also depends upon the number of individuals within the group of all ages, as each individual brings his or her personal experience into the group pool. As the information set depends on the number of individuals, conformities will be group-specific.

Among the factors qualifying performance of, if not absorption of, conformities are age and status. The older animals are the greatest repository of 'wisdom', meaning the amount of information as well as the experience and practice of it. The position that older animals hold in most monkey societies makes them most obvious to the group: literally, 'seeable'. The information that older monkeys display, therefore, filters through the group.

Such information tends to be conservative; the repetition of patterns that have been witnessed before. This process is due, at least partially, to the fact that acquisition of new concepts is hindered by habits (Myer 1971). But even in a closed monkey society, information content does not degrade because the young produce information (Stephenson 1973). Young animals play. Through play new patterns are happened upon; innovations occur. The practice of these fixes them within the repertoire of the chance (or purposeful?) innovator. The spread of the innovation will depend on the observability of its carrier. With maturation as the only factor involved, the innovation will have the opportunity of moving up a narrowing pyramid, as the number of animals within the society de-

creases. With fewer performers, these fewer actions are more visible, and hence more likely to be imitated, especially by the young, who do not view the action as 'new'. Hence by the time these young are old, the information will have become typical to that group, or at least to quite a few of them. The information that is stored within a group, therefore, has a natural turnover and progressiveness. It has perpetual alterations inherent within it. Should the practitioner, during the course of his/her maturation, be a prominent individual, the likelihood of the action being repeated increases.

It is probable that, after a long succession of generations adapting in a changing environment, no patterns of the set A will have been maintained with enough fidelity to be recognized by an observer in the current updated set of cultural patterns of a particular group. (Stephenson 1973: 51)

This phenomenon of the perpetuation and innovation of the information pool as socially transmitted has a biological parallel. The information that is stored in the DNA is transmitted from generation to generation and is conservative.

Mitotic replication ensures delivery of a complete set of identical information to the next cellular generation. There is, however, at cellular division of germ cells, a radicalization of biological information transmittal. The chromosomal actions in meiosis guarantee a recombination of information such that the new individual holds innovations. Hence biological conformities are analogous to social ones, permitting metaphoric allusions. But they are not homologous, as behavioral patterns are assimilated from social options while biological patterns rise from the genome in each individual. While the individual draws once from the gene pool in order to be, it continuously draws from society in order to become. The ability to perceive and absorb societal patterns depends on higher-order processes.

Field observations: Purposive behavior

Evidence of higher-order processes is inferred from observations of daily behavior. Studies of several species of Cercopithecus and Macaca have led to the awareness that simple models of nonhuman primate behavior are inadequate to explain the phenomena observed. For example, purposive manipulation of information has been witnessed in nonhuman primates. Dramatically, but not unexpectedly, such behavior is attested for chimpanzees (Menzel 1971, 1978), whose manipulation of information con-

cerning the source of a hidden object amounts nearly to duplicity. In Cercopithecinae, I have observed a variety of kinds of incidents of manipulation. A juvenile *C. neglectus*, caged (at Limuru, Kenya) in a family group, continued to give infantile vocalizations well past the appropriate developmental stage for them. The situation that most especially evoked the behavior was when strange individuals appeared before her cage.

Infantile cries are obligate stimuli. By looking at her male parent when she uttered the cry, the juvenile female caused him to rush to the front of the cage in a threatening manner. Similar events have been recorded among free-ranging Gibraltar macaques. In recent years four males from one of the two local groups descended from their home area to the second group and caused the death of one of the two adult resident breeding males. The eldest of the intruding four engaged in a complex relationship with one of the older resident females. The latter, it is important to note, was well established within the group; a known breeder for several years and one who clearly had the 'respect' (Burton 1972) of the group members. While the female repeatedly advanced and presented to the male, he repeatedly avoided these advances, but did so while making the 'approach' face: the tooth-chatter toward her, as if seeking to allay her ill-humor caused by his sexual rebuff. On one occasion without his knowledge she followed him to a clearing and lay down in the tall grass. On his return toward the group, the male came up the path toward the clearing, and approaching the clearing tensely, quickly withdrew, sat, and waited. His second approach was no more successful because the female had not moved, but his noise disturbed her, and she rushed to join him. Tooth-chattering at her, he tried to move on, but her grooming motions stopped him.

He threatened her mildly with his eyes, while tooth-chattering with his mouth -- ambiguity in facial gesture is well attested in these animals (Zeller 1980; Steklis and Raleigh 1979). It may be that her attentions were basic, while his were perhaps more base. Due to her central position within the group, she bridged the gap for him and made it possible for him to approach and ultimately groom the last of the incumbent males. In so doing, he was able to decrease hostility, and thus to establish himself within the group.

I label this behavior of his manipulation, because I have frequently seen males threaten females away when their sexual interests led them elsewhere. Since males as well as females react to sexual harassment, the kinds of action this male took, in the context of the incursion that had taken place, strongly suggest that he tolerated her attention for a political reason. By associating with her he made a bid to remain in the group,

indeed in the literal and symbolic center of it. As in the earlier example of information manipulation by the juvenile *C. neglectus* female, this example suggests the manipulation of individuals through the use of information, in this case, facial expression.

There is a form of manipulation, an exaggeration of action, that is frequently observed. Here the monkey is demonstrating purposive behavior in the exploitation of a 'justified' (appropriate, frequently observed) response to a stimulus, but continues the response well beyond the time boundary that is normative for it. For example in Gibraltar, if a young monkey disturbed, harassed, or surprised an adult, it would be 'justified' for the adult to threaten, grab, or cuff the young one. Mild reaction is a 'punishment' and apparently suffices to control the behavior. However, if the adult continued its reaction, that would be exaggerated -- a manipulation of the situation for an inferred purpose. Group approbation, isolation of the offending individual, and change in status have been some of the observed consequences.

Behavioral items, such as grooming, have been used manipulatively for an inferred end. As it is the 'social adhesive' (Burton 1972) uniting individuals within the group, the conferring of grooming by one individual upon another represents an attempt at coalition; conversely, deprivation of grooming represents an attempt at rejection. Grooming is the only 'currency' of nonhuman primates. It is distributed or withheld according to complicated and yet unknown variables (Burton et al., ms.).

One spectacular political instance of purposive behavior concerned an adult female, at the time nine years of age, and the youngest of the fully adult females. She was observed between 19'10 and 1973 in a complicated maneuver. It concerned older adult sisters (B and W) and the daughter of B (P). Initially, by consistently threatening, chasing, and generally rebuffing W, especially when approached by B, W was isolated. The following year, by consistently grooming, sitting with, and generally remaining near P, J was able to keep P from B. In this way the kin group of P, B, and W were isolated from each other. When friction arose within these kindred, J allied with P against P's mother B. This coalition enhanced J's position against the older females. However, it must not have been sufficient, as J began consorting with two young males, and with them began wandering away from her natal group, as if to establish a new group elsewhere. In so doing, however, she overstepped the human tolerance for monkeys in Gibraltar, and the wandering monkeys were captured and sent to toes. The systematic behavior of isolating certain animals from others and from the group, while courting particular ones, of coalitions and group formation, suggest that this female was purposively attempting to enhance her personal position within a power structure.

Purposive behavior is assumed to have occurred when from hindsight the observer sees bits of behavior forming a complicated unit, whose consequence is also observed.

Anthropomorphism is the intellectual error of attributing human characteristics to nonhumans. In order to avoid this egregious error, efforts to increase objectivity have been made by employing vigorous techniques of observation and analysis (in particular Altmann 1974). In the final analysis, we cannot 'know' the subjective reality for any organism save by inference. We observe, record, and then infer from our own subjective reality; we equate by analogy to information previously certified. The care given the procedure confers credibility to the conclusion.

Information specification: Process

These field observations or anecdotes are examples concerning the transmittal of information, its alteration and purposive use within a nonhuman primate society. The act of recognizing and assimilating conformities, that is, of accessing and processing information, is also observable, or at least can be inferred from observation of behavior.

Because of the number and kinds of information that reach the primate brain, the number of decisions that can be made is a function of the amount of specification that is possible. Classification of information is adaptive, permitting sorting of the plethora of data coming in. The basis for this ability is plausible, inferential reasoning on the basis of recognition of similarities. It is 'analogical', requiring no 'words' (Sternberg 1977), and is a kind of 'thrashing around and searching for knowledge, a matching of similarities, and then a plausible inference [drawn] from that knowledge' (Collins 1975: 82). Bits, bytes, field, files, packages, frames - schemata become joined into a network, a trellis (Gregg 1971). Piaget noted: 'There exists therefore, a practical and cognitive adaptation ... that calls not only for selection's mechanisms of acceptance and rejection, but also for a structuring of the environment by the organism, itself (1978). Menzel, in his important series of experiments on cognitive mapping in nonhuman primates, concluded: 'There is no such thing as free space for an animal. The spatial world is structured by the animal's species characteristics, physical maturity, early experience, and experience in a defined situation' (Menzel 1978: 395).

The more aspects by which information can be classified, the greater the specification. A forest monkey, for example, must be able to process data on trees: its flexibility in dealing with exigencies of forest life is

enhanced by being able to specify trees with certain kinds of branches, able to hold its weight; trees holding food; trees liable to hold danger, etc. Each of these single constructs enables it to specify the object by function or attribute. Field observers note this process of analysis when they record head movement, eye position, movement of eyebrows, and actions with reference to objects.

The classifications adopted are due to the fact that the quantity and variety of information coming into the brain requires sorting, otherwise the system short-circuits. The more aspects by which information can be classified, the greater the specification. Classification as an act includes several other kinds of abilities. Primary classification for a monkey includes identification of others. Initial contact, smelling, touching, and seeing configure images. The inherent differences in the images permit the monkey to discriminate between them, and they become the bases, the data by which classes are formed. The classes, by their inclusions/exclusions permit the animal to predict outcomes. The monkey is thereby literally constructing some kind of taxonomy. The ability to do so is suggested by an observed example concerning food behavior. Monkeys transplanted from one habitat are able to find food readily and relatively easily in a similar habitat. By what means do they generalize from what they have known to the new resources? Is it the shape of the plant, its odor, the nature of the leaves, or just trial and error? The success of the venture is undoubtedly enhanced by the detail with which specification of known foodstuffs is matched by features in the unknowns. Stephenson remarks: 'That one kind of edible plant is selected and another is not leads to the inference that the signal emanating from each selected kind of plant may acquire a correspondence with its source so that it becomes associated with eating' (1973: 36).

That these attempts to identify edible plants are not always successful is documented by the case of Japanese monkeys transplanted to Texas, who died from eating a local weed. It apparently did not take many deaths, however, before avoidance of the plant became typical. We may assume the toxic plant was now included in the class whose members were increased by features of this weed.

Not only are the monkeys able to form taxonomies, they must be able to prioritize in the presence of several competing events or stimuli occurring within their purview. This extension of classifying, of making taxonomies, is observable in the choice of response pattern made from known (previously observed) options. Thus, confronted by an attacking adult female, a screaming neonatal infant, and a delicacy the monkey can be seen to freeze, look about him, and then act. The choice of which act - to flee the attack, retrieve the infant, or grab the delicacy -- cannot be

simply predicted by the observer on the basis of which choice seems best to correspond to 'survival'. The choice of option is predicated on the personality, experience, predictions, and other factors unique to the actor. This behavior of forming hierarchies also implies putting things in sequence according to some set of features; that is, ordering a series. Hulse has reopened the possibility of study of this issue, which has lain dormant since the 1930s for the following reason:'.., it could be that the lack of an appropriate element set -- together with a reluctance to attribute complex cognitive capabilities to animals other than man - may have led to almost 40 years of neglect to the problem of serial order in non-human species' (1979: 315).

For a monkey to 'solve' an ordinary, quotidian problem requires this ability. Suddenly coming upon an abundance of food, the animal must organize his tactics of retrieval -- and this in the presence of others to whom this plenty is also appealing. There is only so much a monkey can carry -- even, as for Old World monkeys, with cheek pouches. Therefore, a sequence of getting, filling pouches, leaving the scene, and returning for more, a serialization of good getting behavior, occurs. When the sequence is time-bound it suggests the formation of chronologies. Confirmation of the possibility of a sense of time has been made experimentally by Church, who notes that 'animals learn to adjust their behaviour in a manner appropriate to a time interval' (1978: 279). Church feels that 'internal clock' is not a metaphor but a real phenomenon whose implications are discoverable.

Accepting that a monkey is establishing a sequence with reference to time present and time future, as in the present example, is less trying than accepting such an ability for time past. Field observers recount instances of watching monkeys sitting quietly, when all of a sudden one of the observed runs, or vocalizes. Yet nothing has 'happened'. There has been no observable stimulus. Given Griffith's (1976) cogent argument that dreams in animals are the projection of self in a scene, it seems the animal in the above situation may be reacting to a recalled image. The projection of a remembered occurrence including one's own person is the primitive adumbration of displacement and recognition of time.

It may be argued, however, that the immediate reaction to an image implies that the animal is responding to a stimulus in the present. If the animal were acknowledging or involved in the past there would probably be 'meditation' and no action. Meditation is far too subjective, however, to attest by observation!

Gallup's studies with mirrors (1970) have shown that the apes but not monkeys have the ability to equate their mirror images with their own bodies when these have been marked with paint. The visual identification

of self is apparently beyond the monkey. However, the monkey's unexplained and sudden behavior may have the remembrance of emotional arousal as its antecedent. The stimulus, then, is not the visual image, but the situation refelt.

Differences in brain structure delimit function between species. There are great differences in abilities between monkeys and apes, let alone monkeys and humans. Yet the generally held assumption is that ecological strictures or genetic competition are unwarranted. Social behavior is the adaptive response of primates, and flexibility is their hallmark. The development of primate mental abilities suggests a premium placed on the subtle evaluations that inhere in group living. Human behavior has its origins in the capabilities inherent in nonhuman primates. 'A cultural set of behavioral interactions with components of the environment has the advantage of rapid updating of any of the subsets of patterns which become outmoded. [This is the] basic biological function of culture among primates' (Stephenson 1973: 49).

Summary

In this paper I have enumerated some of the mental abilities apparent to observers in the field. Field observations are chosen because under these conditions animals are not even unwittingly guided. Because monkeys can discriminate by their senses between same and different, they are categorizing or classifying, or forming taxonomies. In turn, this ability indicates competence in forming hierarchies and establishing priorities. The ordering of information in a series implies the primitive beginnings of forming chronologies.

Behavior exerts its own evolutionary force; it is a circular process: the greater the reliance on social behavior the greater the pressure to develop traits that enhance it.

Note

1. A version of this paper was first presented as part of a course during the International Summer Institute for Semiotic and Structural Studies that took place in Toronto, June 1980. 1 wish to thank Paul Bouissac for having invited me to participate in this stimulating series of lectures and discussions, and to Thomas A. Sebeok for the opportunity to be discussant at his lecture (subsequently published as 'Naming in animals, with reference to playing: A hypothesis' [Sebeok 1981]).

The research discussed was done over a ten-year period in Gibraltar. and I thank the British Army for permission to study the monkeys, and for their hospitality and

assistance. Parts of this research have been funded by the Boise Fund, Oxford; the NRC of Canada (now NSERC), the University of Toronto Social Science and Humanities Grants; and EARTHWATCH.

I appreciate the comments of John Deely, Michele Broderick, and Stephen Fields, whose thoughts and criticisms at various stages of the draft have been most helpful. Without Annabelle Lansing this paper would not have been possible.

References

Aldrich- Blake, P. (1970). Problems of social structure in Forest monkeys, in *Social Behaviour in Birds and Mammals*, J. H. Crook (ed.), 79-102. New York: Academic Press.

Altmann, J. (1974). Observational study of behavior: Sampling methods. *Behavior* 49 (304), 227-267.

Burton. F. D. (1972). The integration of biology and behaviour in the socialization of *Macaca sylvanus* of Gibraltar. In *Primate Socialization*, F. Poirier (ed.), 29-62. New York: Random House.

Carpenter, C. R. (1964). *Naturalistic Behavior of Non-Human Primates*. University Park: Pennsylvania State University Press.

Church, Russell M. (1978). The internal clock. In *Cognitive Processes in Animal Behavior*, S. H. Hulse, H. Fowler, and W. K. Honig (eds.), 277-310. Hillsdale, N.J.: Erlbaum Associates.

Collins, A. and Loltus, E. (1975). A spr action theory of semantic processing. *Psychological Review* 82, 407-428.

Deely, J. N. (1971). Animal intelligence and concept Formation. *The Thomist* XXXV(I). 43-93.

Gallup, G. G. (1970). Chimpanzees: Self-recognition. *Science* 167, 86-87.

Gregg, L. W. (1971). Similarities in the cognitive processes of monkeys and man. In *Cognitive Processes of Non-Human Primates*, L. E. Jarrard (ed.), 156-163. N.Y.: Academic Press.

Griffith, D. R. (1976). *The Question of Animal Awareness*. New York: Rockefeller University Press.

Hall, K. R. L. (1963). Observational learning in monkeys and apes. *British Journal of Psychology* 54, 201-226.

----------(1968). Social learning in monkeys. In *Primates. Studies in Adaptation and Variability,* P. C. Jay (ed.). 383-397. New York: Holt, Rinehart, and Winston.

Hooton, E. (1954). *Up From the Ape*. New York: Doubleday.

Kohler, W. (1927). *The Mentality of the Apes*, 2nd ed. London: Routledge and Kegan Paul.

Lindburg, D. G. (1973). Grooming behavior as a regulator of social interactions in Rhesus monkeys. In *Behavioral Regulators of Behavior*, C. R. Carpenter (ed.), 124-148. Lewisburg: Bucknell University Press.

Menzel, E. W. (1971). Communication about the environment in a group of young chimpanzees. *Folia Primatologica* 15, 220-232.

----------(1978). Cognitive mapping in chimpanzees. In *Cognitive Processes in Animal Behavior*, S. H. Hulse, H. Fowler, and W. Honig (eds.). Hillsdale, N.J.: Erlbaum Associates.

Myer, D. R. (1971). The habits and concepts of monkeys. In *Cognitive Processes of Non-Human Primates*, L. E. Jarrard (ed.), 83-102. New York: Academic Press.

Nissen, H. W. (1931). A field study of the chimpanzee: Observations of chimpanzee behavior and environment in West French Guinea. *Comparative Psychology Monographs* 8(1), 1 -22.

Passingham. R. E. (1979). Specialization and the language areas. In *Neurobiology of Social Communication in Primates*, H. D. Steklis and M. J. Raleigh (eds.), 221 256. New York: Academic Press.

Piaget, J. (1978). *Behavior and Evolution*. New York: Pantheon Books.

Sebeok, Thomas A. (1981). Naming in animals, with reference to playing: A hypothesis. *Recherches semiotiques*/Semiotic Inquiry 1, 121-135.

Steklis, H. D. and Raleigh, M. H. (1979). Requisites for language: Interspecific and evolutionary aspects. In *Neurobiology of Social Communication in Primates*, H. D. Steklis and M. H. Raleigh (eds.), 283-314. New York: Academic Press.

Stephenson, G. R. (1973). Biology of communication and population structure. In *Behavioral Regulators of Behavior in Primates*, C. R. Carpenter (ed.), 34-55, Lewisburg: Bucknell University Press.

Sternberg, R. J. (1977). Component processes in analogic reasoning. *Psychological Review* 84, 353-378.

Washburn, S. L. and De Vore, I. (1961). Social behavior of baboons and early man. In *The Social Life of Early Man*, S. L. Washburn (ed.), 91105. Chicago: Aldine.

----------(1963). Baboon ecology and human evolution. In *African Ecology and Human Evolution*, F.C. Howell and F. Bouliere (eds.). New York: Wenner Gren Foundation.

Zuckerman, S. (1932). *The Social Life of Monkeys and Apes*. London: K. Paul, Trench, Trubner.

Zeller, A. (1980). *Facial gestures in Macaca sylvanus of Gibraltar*. Unpublished Ph.D. dissertation, University of Toronto.

Frances D. Burton (b. 1939) is a Professor of Anthropology at Scarborough College, University of Toronto. Her principal research interests are the social behavior of nonhuman primates, the relationship of biology and behavior, and this process in human evolution. Her publications include 'Sexual climax in female *Macaca mulatta'* (1971),'The integration of biology and behaviour in the socialization of *Macaca sylvanus* of Gibraltar' (1972).'A drift in time can define a deme: The concept of tradition drift' (1972), 'Ethology and the development of sex and gender identity in nonhuman primates' (1977), and 'Birth intervals in *Macaca sylvanus* of Gibraltar' (1982, with L. Sawchuk).