Lecture 8 Introduction: Baboon Metaphysics

Over the last few decades, during which the books being reviewed in this set of lectures were being written, there has been a fundamental shift in our understanding of the capabilities of non-human primate minds. In the 1990's the predominant viewpoint and research focused on investigating the argument that conceptual abilities were directly tied to increasing neural overdevelopment in human brain growth (Finlay & Darlington 1995: in Parker, Langer & McKinney 2000) which was allowed by extending the length of ape and human pregnancy and thus prenatal brain growth. This was augmented by the concept of extra fetal gestation as an adaptation by humans so that their neural pathways were considered to develop at fetal rates for the first 9 months of life providing extra time for specialization of various areas of the brain. This argument refuted the idea that human brain/ body rations were the result of neotony (juvenilization) , but argued that the increasing length of time for neural maturation resulted in the larger brain of humans which continued to differentiate develop and mylenate until the human child was 12 years old. This purely physiological approach to cognitive development was augmented and succeeded by a variety of work by both field researchers and lab work done by various investigators who argued that the cultural and social aspects of learning were more relevant than pure neural size and complexity. In particular, observational learning abilities began to be observed and tested in an attempt to investigate the potential capabilities of non-human minds. Unfortunately Povinelli's very influential research (eg. Folk Physics for Apes: 2000), while utilizing socially raised chimpanzees began their testing sessions while the subjects were 2.5 to 3.5 years old and more than half the tests were conducted before the animals were 8 years old. Thus these were basically infant and juvenile chimpanzees, whose brains do not develop even as fast as human children. Thus is it is not surprising that the types of complex choice tests they were given did not provide results supporting the high level model of understanding the relationships between the object which they manipulated and the conditions of the test, or how the tool was related to a successful outcome. These results might have been different if more mature animals had been used, in spite of Povinelli's argument that because 4 of the females had given birth by the time the tests were finished that they could be classified as adults. They did not have adult chimpanzees to learn from of interact with and were no more mature than adolescent girls who become mothers. Nonetheless many of the animals succeeded at some level with the trials although they did not always use the optimal solutions in the way that a human who understood the conceptual nature of the problem might have done. From these results Povinelli concluded that although the performance of humans and chimpanzees might be similar "this does not mean that the same physiological processes have produced them" (325). From this he argued that improvements in performance related to experience do not necessarily mean that there is an improvement in the comprehension of the task.

One of the problems with understanding possible changes in the comprehension of tasks, which is based on an understanding of how the world operates, is ascertaining what aspects can be learned by observation, and what aspects have to b e learned by

direct experiment by each individual, in order for learning to occur. In this case one cannot readily asses “the monkey” or ‘the chimpanzee” but really has to take into consideration the social and environmental as well as intellectual abilities of the subject. To get a really relevant basis from which to argue I feel that these bases should be field experiments and observations conducted on free ranging animals in living in the habitat to which they are adapted. Thus, when trying to answer the current important cognitive question of modern primatology DO PRIMATES HAVE A THEORY OF MIND? (which is an ability to know what another conspecific is feeling or thinking or intends to do) the work of Cheney and Seyfarth on the baboons of the Okavango Delta provide data which allows us to attempt to assess the conceptual abilities of these primates.

This development in investigating the mental capacities of primates over the last two decades from a focus on the physical nature of the mind, through lab and experimental attempts to assess conceptual skills to an understanding of problem solving in an ongoing social setting gives us a broader bases from which to understand how primates perceive themselves and each other as well as the world around them. Although Cheney and Seyfarth ‘s earlier book “How Monkeys see the World” which utilized a similar methodology but from an ecological perspective began this series of lectures/reviews it was focused on the semiotic potential for primate communication. The discussion of ‘Theory of Mind’ in “Baboon Metaphysics” concerns the theoretical implications of the extent to which an observer can assess the intent of another animal. This is one of the most important theoretical aspects of the book since in order for monkeys to assess another’s intent they much have a concept of themselves as different from the other and the idea of self concept in monkeys is currently under intense investigation. Cheney and Seyfarth adopted William Tenning’s model in which there are a number of levels making up the faculty of self awareness. Clearly one cannot be aware of another animal’s mental state if one has no concept of one’s own. These levels begin with the basic level of material condition eg. hunger, pain or fear, which each animal must know for itself in order to survive. Then comes the social level; each animal as a distinct actor in the group. This differentiates group living animals from aggregates or hordes, who have found safety in numbers without having social relations with other members who live nearby. A third level is referred to as introspection, thinking about what we know. It is sometimes called metacognition, but does not necessarily require a complex level of thinking about what we know. For example, a dog can remember that his ball is under the sofa or left outside, but may not be able to reason how to retrieve it or why it would be better if he didn’t retrieve it right now. On the other hand most higher primates can delay retrieving something until conditions are optimal for retaining it or figure out complex ways of getting something out of reach, sometimes by using a tool. In terms of tests for self awareness, while apes can generally pass the Gallup mirror self recognition test, (there is some discussion about gorillas, but my personal experience is that they can do this) mirror self recognition is not something that baboons or other monkeys have demonstrated reliably. The interesting question is why this is the case and Cheney and Seyfarth discuss the levels of self awareness that may account for this. In particular,

the authors discuss the meaning of representation which is a major part of self awareness, since for a non verbal animal their concept of self may be strongly related to self representation (how I present myself to the world), but the concept of representation in communication is a very complex one. They finally conclude that baboons have concepts for which they have no words which supports the idea of thought without language. This is a very controversial position but they have proposed an argument to support it as well as a discussion of possible refutations. A comparison of the viewpoints of the books covered in this series of reviews gives us an appreciation of the upward spiral of our understanding of the minds of our closest living relations and how this impacts our understanding of ourselves.

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Baboon Concepts

Dorothy L. Cheney and Robert M. Seyfarth, *Baboon Metaphysics: The Evolution of a Social Mind*. Chicago and London: The University of Chicago Press, 2007.

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Cheney and Seyfarth begin this odyssey through the evolution of the mind with a quotation from one of Charles Darwin's notebooks: "He who understands baboons would do more towards metaphysics than Locke" (1). Darwin wrote this in 1838, just two years after returning from his voyage on the Beagle, and years before he had clearly formulated his theory of Natural Selection. What Darwin understood, however, was that animal behaviour, and by extension human behaviour, was based on a combination of innate, inherited tendencies and reasoning based on experience. This combination of underlying causal mechanisms was responsible for both physical activity and the life of the mind. Thus, Darwin became excited by the possibility that his developing theory of small variations becoming reified by their contributions to successful life and reproduction was just as relevant in tracing the course of mental development as for tracing morphological evolution.

Like Darwin, Cheney and Seyfarth base this book on a solid foundation of observations taken in a natural setting. Their earlier work on vervet monkeys, How Monkeys See the World (1990), drew on many years of observations in Africa and provided a firm foundation of observation and experiment to support an interpretation of vervets as highly social monkeys who are best known for their complex communication system,

incorporating learned vocalizations to refer to different varieties of predators. As their research revealed, vervets also use a wide variety of additional vocalizations in very specific ways.

Cheney and Seyfarth moved on to studying baboons in 1992 partly because baboons live in larger social groups and are among the most intensely studied African terrestrial monkeys. Terrestrial primates are much easier to keep track of and conduct experiments with since they are easier to see than primates who disappear into the crowns of trees and can thus escape the observer. Early research on baboons was partly based on their use as a model for the development of early hominids. Since group life is essential for survival on the African savannas, how do non-linguistic forms organize themselves, escape predators, and raise their young while still finding enough to eat and safe places to sleep? More modern models are based on the chimpanzee (taxonomically closer to humans), but functionally, baboon groups face more similar lifestyle challenges to early hominid groups.

However, Cheney and Seyfarth are more interested in the complex social network which baboons develop and how their mental abilities in developing, remembering and understanding social relationships impact their reproductive fitness. There are several theories about what selective pressures drove the mental capabilities of primates (and other animals). Was it ecological pressure, the need to find sufficient high-quality food, and the need to use social reinforcements to escape predation? Or was it the need to live in a complex social group in order to survive? Those who argue that ecological pressures are most relevant cite the need for groups to construct mental maps of the resource locations in their ranges, which may spread over tens of square kilometres and to predict when various food sources may become available. The argument is that leaf-eaters with small ranges and a monotonous, easily found diet have less extra brain development than forms that must search out ripe fruit, hidden resources and use complex foraging techniques to extract their food.

The Social Intelligence Hypothesis, which is the viewpoint being supported in this book, is based on the idea that social integration and intelligence are crucially important to both males and females and probably evolved together in a self-reinforcing spiral (Jolly 1966). The authors spend the first two chapters looking at the history of studies on the intellect from 18th and 19th century philosophers to 20th century behaviourists and the range of evidence that has become available through observations and experiments conducted on a wide variety of animals and birds. The variety of species studied has made it clear that it is not the raw size of the brain that influences intelligence but the organization and relative size of its various parts. Some birds have brain circuitry that expands and contracts during the course of the breeding cycle, allowing them a wide complexity of breeding songs when needed, but not using up cranial space when other activities such as migration were of uppermost importance. Some have very specialized circuits allow them to hide and subsequently find thousands of seeds. Brain differences between monkeys and apes include both brain/body ratio and also the relative size of the frontal/prefrontal cortices that are

larger in apes and still larger in humans. This specialization impacts the level of higher order brain processing such as empathy, logic, conscience, forward planning, and other abstract mental skills.

Chapters 3 and 4 introduce us to the groups of baboons under study and to the ecological situation in which they live. The Okavango Delta of Northern Botswana is a periodically flooded area of savanna, forest and riverbank with highly variable ecology over the course of the year. This provides a wide range of niches for the baboons to exploit and provides a home for many other species as well. The periodic flooding is a major stress especially due to large populations of crocodiles, and to the potential for youngsters to be lost.

The social behaviour and life histories of males and females, including their hierarchal relations, are introduced and an indication of familial complexity, alliances, friendships and Machiavellian intrigues is outlined. For those who do not know much about baboons, these three chapters make it clear how complex their social relations are and how much memory and ability to classify is required to keep 80 to 100 individuals and their complex relationships in mind. Baboons have to know every other individual in the group – including details about age, sex, kin group, rank, friendships and alliances. Male dominance ranks are quite transient as males immigrate and emigrate as well as compete daily for higher rank positions. Female hierarchies are more stable, but the matrilineal groups can be quite large and ranks within them can change as individuals mature.

Once the situation is introduced, the next pair of chapters, five and six, cover a range of naturalistic playback experiments designed by the researchers to test the expectations of the monkeys about how their social world is organized. As with the vervets, Cheney and Seyfarth determine that mothers recognize the calls of their own infants and juveniles and know who the mother is of other youngsters. They explore the ‘grunt’ vocalization used in a wide range of contexts. It can be a friendly reconciliation by a higher ranking female to a lower ranking one, after they have had an altercation. When two females have had a fight, the authors would playback a ‘grunt sequence’ from the higher ranking female (who was out of sight) and this would result in the lower ranking one either approaching or not running from the high rank female when they next encountered each other. If no ‘grunts’ were played and the high ranking female did not give them herself, the next encounter would usually result in the retreat of the lower ranked female. Thus it was clear that the ‘grunts’ were effective at reconciling the two individuals. However, a grunt from another female of the high ranker’s matriline would also serve to affect the lower ranked female’s behaviour. The lower ranked female interpreted the grunt from the other female as a proxy for the intention to reconcile by the female she actually fought with. It was clear that this willingness to approach was only directed at those two members of the high ranked matriline and not to the entire membership. In other words, ‘one did not stand for all’, but one individual could act on behalf of another. The question becomes: did the lower ranked female attribute an ‘intention’ to reconcile to the female who had not grunted? She seemed to attribute the

‘grunt’ as being directed towards herself, but we still do not know what that vocalization actually meant to her.

Another type of experiment undertaken was to play a sequence of ‘fear bark’ and ‘grunt’ by two individuals to a third female. If the fear bark was by a lower ranking female and the grunt by a higher ranking one, the listener hardly lifted her head. However, if the bark was by the higher ranking one and the grunt by the lower, the listener looked very intently in the direction of the ‘playback’ speakers. Cheney and Seyfarth interpreted this response as one in which the listener’s expectations of rank order were not met and they were surprised. The control sequence for this experiment was to include a ‘grunt’ by an even higher ranking female, which seemed to be interpreted as two females grunting to a mid-ranked female who fear barked to a the higher ranked one, all of which would be a normal interaction. A number of different experiments of this general type made it clear that baboons recognize the voices of other individuals, know which matrilines to which they belong and their relative ranks. They respond very quickly to the playbacks suggesting that the information about identities is easily retrievable. It also seems clear that they assume a causal relation between vocalizations that are closely spaced in time and location even when they do not see the sender. This recognition suggests “that they are making inferences about both the intended target of a signaller’s call and the signaller’s motivation” (109). This is a new idea for researchers who “have only recently begun to entertain the possibility that baboons and other monkeys might be able to attribute simple mental states like intent to others” (110).

What reproductive impact (selective pressure) would this ability enhance? The two major factors governing a female’s reproductive success are the abilities to avoid infanticide and predation. Predator defence works much better in a group. The most socially integrated females are those who live the longest and successfully raise the most offspring. If an infanticidal male moves into the group, a female needs support from male friends to help protect her infant. She needs to recognize which males already have as many female friends as they can protect and which ones are likely to assiduously protect her and her offspring. Mothers and sisters can also be some help in protecting, but if they have died a female must establish strong social bonds with other females by grooming, alliance formation, and supporting the kin of their newly chosen social partner. Females can only afford so much time to establishing and maintaining these bonds so they must choose their potential allies with knowledge of their willingness to participate and their ability to help. With a group of 80 to 100 animals, it is not just a matter of associative learning and conditioning which establishes these bonds, but a weighed social choice. There are over 3,000 potential dyads in a group of 80, and a female cannot spend the time to try out each one to find a bond that works. Further, there are many different types of social relationships, mates, friends, kin bonds and enemies, all characterized by differing behaviours and spatial proximity and some relationships are more transient than others. Thus it seems unlikely that all primate social knowledge results from simple learning mechanisms. Instead, it seems probable that natural selection has favoured animals who are

predisposed to arranging their companions into rule-governed classes. This ability to classify is the basis of implicit social theories, about kinship, about rank relations, and about behaviour expected between friends.

The conclusions arising from the field experiments lead into a more intensive discussion of the Social Intelligence Hypothesis first discussed by Eugene Marais in the early 1900s. Ethological studies demonstrate that natural selection works on both physical structure and behaviour. Flying, for example, is an activity that requires a particular anatomy. But it also requires a particular behavioural activity. Behaviours are impacted, in fact governed, by the neurological structures supporting them. The mental behaviour of making abstract judgements, categorizing, and learning associations is part of what makes social primates successful. Modern neurophysiological techniques now allow us to ascertain with exactness which locations in the brains of both humans and primates are activated when particular tasks are undertaken. We now know that when animals observe behaviour it affects the brain in the same areas as actually performing it, and this gives a solid base to understanding learning by observation, which is how most primates learn, since direct teaching is rare.

It has been suggested that technology and innovation, rather than skill in social interactions, has governed the development of higher intellect in apes and humans. This is supported by the argument that tool users such as capuchins, chimpanzees and orang- utans have larger prefrontal areas and higher encephalization quotients than monkeys, although they live in smaller groups. I would like to argue that at least for chimpanzees and orang-utans, the number of animals they know may be smaller but that each species lives in a very complex far flung group, in which they only rarely see some of the members. Just because orang-utans are not in daily contact with others does not mean that they do not know and interact with a potentially wide range of other individuals. These include offspring, other females in neighbouring ranges, resident males, transient males, and their own mature daughters. The need to keep social identity in mind over periods of years between interactions should be counted as an attribute of social complexity rather than just focussing on the number of animals in a group. This also applies to chimpanzees, who only rarely meet some members of their communities. Returning again to Jolly's 1966 version of the Social Intelligence Hypothesis, the authors argue that it is possible that a limited understanding of intentionality and the ability to classify spring from similar selective forces to those supporting the rudimentary technological and innovative skills found in chimpanzees. In other words, the selective values supporting planning, recognizing other's goals and intentions, and the ability to learn from others underlies both social and technological intelligence. The authors argue that these skills are all required in successful baboon communication and therefore spend the last chapters of the book focusing on theory of mind and primate communication.

One of the most interesting questions they ask is whether monkeys have a different type of social knowledge than other gregarious hierarchically organized animals such as hyenas or dogs. They suggest that the baboon's ability to track short-term rank

changes, classify others into higher order groups, distinguish within equivalence classes, make indirect causal inferences and recognize social relationships both in their own species and in others, may differentiate primates, but these capabilities have not been tested adequately in other species so we do not know if these are specifically primate capacities.

Chapter 8 is especially devoted to an examination of the theory of mind and intentionality starting with examples drawn from children. The chapter discusses the age at which infants appear to understand the referential aspects of gaze direction, and in particular, how children can learn new words by watching adults labelling their environment. Within the first year, they seem to understand the intent to refer to the thing the adult is looking at, and by age 1 begin to use gesture and sound to recruit adult attention to themselves and the things they want to focus on. By age 2, children begin to distinguish between ignorance and knowledge in others and have already begun to understand the goals and motives of others. These experiments are contrasted to anecdotes concerning baboons because field experiments are unavailable. Interestingly, some baboons seem more capable of deducing intent, hiding from others, and attempting deception than others. Some will return to rescue their young when facing a long swim in the flooded Okavango Delta while others blithely leave them, to follow or not, as they are able. In other words, some see that the agitation of the youngsters relates to them, and others do not, with the result that some juveniles are lost or drowned. The problem in attributing this type of activity to a 'Theory of Mind' is that it can be equally interpreted in terms of contingency learning ("If I go back for the kid, it will stop screaming"). Various experiments concerning 'seeing' and 'knowing' have been conducted with captive monkeys, chimpanzees and a variety of other species like dogs and ravens. Both of these non-primate species are quite aware of the importance of gaze direction in acquiring knowledge. One dog 'Rico', a border collie from Germany, could be taught the name of an object when the owner merely looked at the toy and said the name. The dog has a receptive vocabulary of over 200 labels, remembered the word in the first trial of retrieving it from a group of items, and continued to recognize it thereafter. Ravens and other seed-caching birds retrieve their cached items much more quickly when another bird, who had watched them cache the food, was released into the pen than when another bird, who had been present but visually occluded, was released. In other words, the birds acted as if they knew that the one observer had knowledge of where the food was hidden, and the other did not. These abilities suggest an understanding of the potential behaviour of others, which rivals the level shown in monkeys.

One of the attributes of baboons, however, is their use of vocalizations to signal and assess intent. Whether the 'intent' is a state of mind or an 'intent' to behave in a certain way is not clear and would be difficult to assess on behaviour alone. Without the means to access the reasons why a baboon (or any animal) does something, the best we can do is to devise experiments that can be interpreted in terms of a particular theoretical paradigm. The efforts to discuss 'self-awareness' in baboons in Chapter 9 are based on William James' model that self-awareness is made up of several different

levels. The most basic is the ‘material’ level, the self-awareness of one’s physical experiences, such as hunger or pain. The second level refers to the ‘social’ self, our awareness of being a distinct individual, while the third is the ‘spiritual’ level at which we can engage in introspection and think about what we know. This level can be called metacognition and does not always require a conscious direction of thought. There are things we ‘just know’ as opposed to the things we can remember learning. These two forms of knowing are characterized as ‘semantic’ and ‘episodic’ memory (Clayton et al 2003). We know these are distinct because some forms of amnesia affect one type of memory but not the other, thus dividing our self-conscious awareness into several components. Thinking about our own actions and beliefs fires the same neurons in the human brain as thinking about the possible motivations and actions of others. It seems we must be aware of our own motives before we can be aware of others. Children develop this skill; the question is, can animals? They can certainly remember a wide range of individuals, locations and events, but they may not be able to plan in advance in the ‘time traveling way’ in which humans lay out potential future scenarios. Baboons often behave as if they were planning but since they do not pass the Gallup mirror test for self-recognition, it is difficult to say that they can mentally project themselves into the future. However, whole series of experiments on various primates are discussed in which the animals demonstrate the ability to accurately judge what they know, whether or not they are explicitly aware of doing so. They are certainly aware of whether, even in a noisy active group, a particular vocalization or facial gesture is directed at them. Thus their level of self- awareness may be mainly at James’ physical and social levels, but the evidence suggests they see themselves as unique social beings, which is a major step along the way to the development of the interaction between selective adaptations and consciousness.

Humans can be seen to understand their own consciousness because of their ability to use a semantic, syntactic system to discuss what they are thinking about. The study of animal communication has struggled forward from the idea of a totally innate, unmodifiable system to our realization that learning is an important aspect, especially in primate systems. The actual call types may be hardwired and species specific, but the timing, direction, recipient and context which characterize such vocalizations are highly variable and socially governed. Some primates, and other animals, have distinct calls to indicate specific predators. Of more interest are those species where the males and females use different calls to indicate the same predator, and respond to the males’ call, the females’ call and the predators’ call (eg. leopard growl) as all indicating the same thing. This occurs in Diana monkeys (Zuberbuhler 2000), who are fairly closely related to vervets, the first main species studied by Cheney and Seyfarth. The interesting difference is that the vervets both produce and respond to the same particular predator alarm call, while the Dianas produce and can respond to distinct ones produced by each gender (acoustically quite different) but which mean the same thing. Production and comprehension are two very different aspects of the communication system and the ability to group three acoustically different sounds (predator call, male call, female call) into one class is an abstract level of classification that could be called semantic. The same type of ability occurs in baboons with the

male alarm ‘wahoo’ call and the female’s ‘alarm bark’. In addition, the authors strongly feel (although they have not experimentally demonstrated) that a baboon ‘crocodile alarm’ differs acoustically from a ‘mammalian predator alarm’. They are certainly responded to differently in an appropriate manner. The other interesting aspect of these calls is that each of them grades acoustically into another type of call. ‘Wahoos’ are also used by males when competing with each other, while the female ‘alarm barks’ also grade into the ‘contact call bark’. Thus, these sounds have semantic content, learned attribution, and specificity in spite of sounding similar to other signals. Female grunts are also graded from the ‘let’s all move’ grunt to the ‘infant contact’ grunt but baboons respond appropriately to these as well. Move grunts occur when influential animals are getting ready to move and are differentially given at high rates when the move is potentially dangerous, thus indicating situational context. ‘Infant’ grunts occur when one female wants to approach a mother with a new infant but are also used in a range of friendly interactions and are thus quite generalized in function but directed towards a specific individual rather than the whole group. The levels of information encoded in these calls argues against the position that they are solely emotional responses. While many people have argued against the referential nature of primate vocalizations, the authors’ position is that calls should not be dichotomized, in terms of causation, into these two categories. They state that “the affective and referential properties of signals are also logically distinct” (229) since they may be easily affective for the sender and referential for the receiver. Also, the ability to subdivide ‘graded’ calls into specific, situational referents argues against a distinction between human ‘discrete’ words and animal vocalizations.

Having made these points, Cheney and Seyfarth then criticize the representational theory of animal communication. We do not know where in the brain ‘meaning’ is coded. In fact, according to Quine (1960) we do not really know what meaning is, except for what we each individually mean by a word. But whether or not we mean exactly the same thing by a word, it functions to provide rich information even if the meaning is imprecise. The same goes for primate vocalizations. Baboons know a signaller’s age, gender, individual, context, often rank, and maybe who they are interacting with. Just by listening, the signaller’s identity provides a host of social information in a cohesive social group.

We humans have a very different system to primates but the differences are not those of Bickerton’s ‘proto-language’ and language. Rather, they are systems that differ in size (number of call types) relationship between words and sentences, and differences between production and reception. The call systems of primates have an arbitrary association between sound and referent. The call meanings are defined not just by the referent object but in relation to other calls in the animal’s repertoire. Leopard alarms are a different class from eagle alarms. Moreover, the referent (such as a leopard for Diana monkeys) is a concept, referred to by three different vocalizations and cross-modally by visual and olfactory cues. Thus, the cognitive mechanisms that underlie call perception are complex with a “rich conceptual structure in which calls are linked to both objects and relations in the world and to other calls in the species

repertoire" (262). The conclusion here is that baboons have many concepts for which they have no words, which is the reverse of the view that thought requires language. This argument suggests that the baboons, and many other primates, behave as if they were capable of thinking even if they do not produce sentences and have no syntactic structure. They cannot generate new words, connect them syntactically and may not attribute mental states to others. This differentiates their communication from that of human children. However, their assessment of complex calls relies heavily on rule-based expectations. They can assess the social relations between unseen signallers by the calls and have expectations about the structure of the interaction. The grouping of calls in an interaction has a meaning greater than the sum of the individual calls and this makes the baboon communication system both complex and productive (268).

When evaluating aspects of social knowledge reflected in the communication system, Cheney and Seyfarth list six important precursors of syntax. Knowledge is representational, and based on properties of discrete information (for example, identity). The discrete value traits can be combined into a hierarchically structured set of social relations. Social knowledge is also rule-governed and open-ended, with the potential to add new members to the hierarchy or to construct many messages from a finite group of signals. These signals can be combined and re-combined to provide a variety of narratives and lastly, information can be acquired through a variety of channels. This list of attributes bears an important resemblance to syntax even though primates do not have the use of 'words' as we know them. This is very different from the concept of a proto-language. In some ways, it is the reverse. The mental attributes could have preceded the vocabulary required to express them.

This set of arguments provides a strong basis for the position that social intelligence and the selective pressures required to produce it may have paved the way for the technology, innovation and developing cognitive skills of the hominid line. The human mind is qualitatively different from all other species but the development of a theory of mind could easily have facilitated the evolution of the traits we see as human. These would include empathy (recognition of others' mental states), intentionality (recognition of beliefs), categorization, motivation to share knowledge leading to cooperation, complex social units and ability to teach, which would allow the development of complex technology. The genetic changes leading to modern phonation abilities are late in evolutionary terms, occurring after the chimp/human split. Since the monkey line diverged from the ape/hominid line at least 20 million years ago, the selective pressures that originally favoured the evolution of social skills have had a long time to produce their complex capable outcomes. In humans, they underlay the development of complex mental abilities, language and technological innovation, while in baboons they support superlative social skills. The thesis of Baboon Metaphysics is that all of these attributes are the result of selective pressures fostering the development of social intelligence.

The collection of data from field experiments on a well-studied free ranging population, captive experiments, and material gathered from a wide range of species makes this

book very interesting as well as strengthening its arguments. I particularly appreciated the authors' efforts to consider alternative theoretical positions and explanations for their conclusions. By doing this, they were able to ask and attempt to answer some of the critical questions that might be addressed to their work. The style was easy to read and the referencing and documentation was thorough. I found the index useful and they included a matrilineal chart of one of the important matrilines, in order to give those who do not know baboons well some idea of the numbers of offspring, lifespan and death rate of free living animals. The only matter I felt they did not deal with, which might have contributed to their argument, was the propensity of monkeys to handle things in their natural habitat and to learn about their qualities by doing so. They refer to the fact that few monkeys use tools; yet systematic observation does reveal that they manipulate natural objects in a variety of ways which may be precursors of object use and tool use. To my mind, it is the vast adaptability and learning potential in young monkeys, so well indicated in the macaque cross-fostering experiment they describe, which allows monkeys who live in large social groups to navigate the social levels that they construct. For those interested in the roots of social organization, or the question of language origins, this is an accessible yet scholarly addition to the literature.

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