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3 The origin of language and cognition

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Two kinds of theories have dominated recent discussion of the origin of language (see Pinker & Bloom 1990): a continuity approach and its counterpart, a discontinuity approach (see Table 3.1). The continuity approach has often labelled itself Darwinian and looked for predecessors of language, typically in animal communication systems. It claims that language is such a big system, that it could not have evolved out of nothing (*de novo*). Just as we cannot conceive of the eye jumping into existence, so we cannot conceive of language as having no precursors.

The opposite position argues that language is unique among the communication systems of the biosphere, and that to claim continuity between, say, bee language and human language is to claim 'evolutionary development from breathing to walking' as pointedly remarked by Chomsky (1972: 68). Language is a task- and species-specific module in the human mind, a 'language organ' (Chomsky 1980a: 76; see also Chomsky 1980b). Chomsky has been one of the few to question a Darwinian explanation of language: 'Darwinian theory is so loose it can incorporate everything', he claimed recently (Horgan 1995: 154).

Beside the Chomskyan position another anti-evolutionary and discontinuity position exists, which could be called *culturalist*. Sociological theories often separate human biological nature from human social nature. The culturalists reject Chomsky's strong innatism, arguing that, basically, humans are unconstrained learning machines who create a culture from which all relevant properties of the human mind (including language) derive. Neither Chomsky nor the culturalists have developed a detailed account of language origins, perhaps partly because their central concerns lie elsewhere. Chomsky has suggested a mutation or plain accident, whereas culturalists have sometimes hinted that a 'leap' from the natural order to the social order must have taken place (e.g.

Table 3.1 Theories of language origin, classified by their assumed evolutionary models and modes of language acquisition

Evolutionary model acquisition mode	***Continuity***	***Discontinuity***
Innate	Bickerton, Pinker, the present author, and others	Chomsky
Learned	'Behaviourism'	Culturalism

Engelsted 1984). Neither explanation is satisfactory and neither will be discussed further.

As indicated in Table 3.1, some continuity theorists also emphasize learning as a fundamental aspect of human mind and language. The reasons for this are, first, their strong anti-Chomskyan attitude — some of them are learning psychologists — and second, the simple fact that language is undeniably learned. The position of these theorists was revealed most clearly in the *ape language controversy* in the 70s and early 80s. Their position was supported by experiments in which different kinds of non-spoken languages were taught to various apes, mostly chimpanzees. Researchers emphasized that even though apes do not speak in the wild, they have a mind capable of learning. By means of a sign language, apes can symbolize external (and internal) states of affairs, and can communicate about these things — primarily with the researchers and lab staff, but also with fellow chimpanzees and their own offspring (the controversy is documented in several places, including Linden 1986). In Table 3.1, I have labelled this position 'Behaviourism'. This is partly a misnomer because nobody really is a behaviourist these days, but the position shares with behaviourism the emphasis on learning (rather than innate structures) in language acquisition. At the same time, one has to remember the strong anti-evolutionary commitment of classical behaviourism — conditioning is the same universal mechanism thoughout the whole animal kingdom, whether Pavlovian or operant.

As can be seen, one cell in Table 3.1 remains for comment. I have not left it till last because it is contradictory to claim both continuity and innateness. These are vague (and relative) terms after all. How continuous does the continuity have to be? Some kind of discontinuity must exist if things are different and not the same. And innateness comes in degrees. Even Chomsky does not claim that language is wholly innate:

to do so would fly in the face of the diversity of the world's living and extinct languages. What Chomsky *has* claimed is that without a strong innate component, language cannot be learned. To my mind his arguments are convincing. I will not defend the position extensively here. But if the child had only inductive strategies for constructing the rules of language, it would either be stuck in an enormous search space looking for consistent rules, or (perhaps) would come up with a language structure different from its parents. Some prestructuring in the child's search lightens the burden of induction and explains why parents and children speak the same language after all. One can also point to the failure up till now, even in principle, of connectionist accounts of language learning (cf. the controversy over the Rumelhart-McClelland simulation of learning the past tense of verbs: Rumelhart & McClelland 1986; Pinker & Prince 1988). So, in conclusion, I follow Chomsky in claiming a strong innate component in human language.

I do not follow Chomsky, however, in his rejection of continuity. Here is how I accept continuity. If language is within the reach of a Darwinian explanation, whatever exactly it may be, then that is enough continuity for me. So, I will evade the question of how continuous continuity has to be by simply remarking that if, by Darwinian means, we can construct a path from a state without language to a state with language, then we have an explanation of how language came about, and need not care whether language developed out of simpler forms of communication (cf. Ulbaek 1990). We then have a fully Darwinian explanation without being committed to the notion that language descended from simpler forms of communication, thereby claiming some essential connection between language and bird songs, cricket songs — or whale songs, for that matter.

The cell in Table 3.1 not yet fully discussed is, then, occupied by my position, and in the following I will further defend the position and show how it gives a general account of language origin without the flaws of the traditional antagonists (but with flaws of its own, no doubt). Unfortunately for my originality, I am not able to claim sole responsibility for this position. Others have similar positions, although none of them is exactly the same: each has put his own fingerprint on the general outlook. Of scholars sharing this position, Bickerton (1990) and Pinker (1994) should be mentioned. What is remarkable about both is that they have ignored the still-effective ban within linguistics on considering language origin worthy of scholarly study: they are heretics

from within the Chomskyan camp. Also in the top left cell of Table 3.1 is Darwinian psychology or *evolutionary psychology*, as its practitioners call it. Leading figures are Cosmides and Tooby (Horgan 1995; Cosmides & Tooby 1987). The importance of their position for the present discussion is that their Darwinian view makes them look for prewired and universal mechanisms behind the surface variety of cultural phenomena.

1 From cognition to language

The correct theory of evolution of language, in my opinion, is this: *language evolved from animal cognition not from animal communication*. Here lies the continuity. Language grew out of cognitive systems already in existence and working: it formed a communicative bridge between already-cognitive animals. Thus, I not only reject the seemingly natural assumption that language evolved out of other communication systems, but I adopt the far more radical assumption that cognitive systems were in place before language (cf. Bickerton 1990). Although times are changing this has not been the most popular point of view in this century — quite the contrary. The so called 'linguistic turn' in philosophy has a broad basis within scientific culture. The traditional stance is that the hallmark of human rationality, thinking, is not only strongly influenced by language, but is even determined by language, or exists solely in language. The Sapir-Whorf hypothesis expresses this strong determinism. Wittgensteinian philosophy demands that inner processes be revealed by outer criteria manifested in language use. These are just two among many converging schools of thought. Also, structuralism and its later developments, in various shades, hold this influential view. I cite Saussure because he is clear: 'Without language, thought is a vague, uncharted nebula. There are no pre-existing ideas, and nothing is distinct before the appearance of language' (Saussure 1966: 112).

Animal thinking is *a fortiori* an impossible, ruled out by the simple fact that animals do not have language. Clearly, a Peircian semiotic is not committed to such a narrow point of view. Nor is a cognitive science for which thinking is calculation across symbolic tokens or mental representations. These mental representations can be wholly in the mind, and (unlike Saussure's *langue*) do not have to be shared by a community of cognitive animals.

In short, we need a theory that does not rule out animal thinking a priori. Animals are not just instinctual machines or learning machines. They are those things, too, as demonstrated by classical ethology and classical behaviourism. But at least some animals are more: they are thinking creatures. Ironically, the battle-cry 'Language is everything, thinking is nothing' drowned the very experiments that could have made scientists, philosophers, and scholars think again half a century ago. Wolfgang Köhler demonstrated elaborate problem-solving behaviour in the chimpanzee as early as the beginning of this century. Even rats evidently do more than just learn a route when running a maze. According to Edward Tolman's account of his experiments (Tolman 1932, 1948), the rats established organized knowledge, cognitive maps, on the basis of which they made inferences, that could not be accounted for by 'habit formation', or any other concept from the behaviourist toolbox. But that was only the beginning. Now a whole subfield of ethology, cognitive ethology, is gathering evidence of behaviour controlled by cognitive processes seen (or, rather, inferred) in a broad variety of species (its first textbook is by Roitblat (1987)). Especially in the apes, many findings point to their high intelligence, and therefore support a view of these animals as cognitive creatures beyond instinctual releasing mechanisms and behavioural modification through learning. I do not have space to go through the data in detail, and so simply note some of the relevant areas.

1.1 Tool-using and making

Apes not only use tools, but also make them. They prepare sticks for fishing for termites (and are seen carrying around 'good sticks'). They use leaves as sponges for soaking water out of trees, and stones for cracking nuts, by arranging flat stones as anvils and using round ones as hammers.

1.2 Cognitive maps

Apes show a sophisticated knowledge of their territory and use this knowledge to plan routes between food areas (Menzel 1978).

1.3 Learning through imitation

Primates are virtually the only order that learn by (social) imitation (Passingham 1982: 176). Ladder-climbing in an enclosure spread rapidly in a group of captive chimpanzees; the spreading of potato-washing

from one individual, Imo (a Japanese macaque), to its group is another example (Passingham 1982: 182).

1.4 Social knowledge

Monkeys and apes conform to a pecking order in their groups, with a dominant alpha male and lower-ranking males and females, and they know each other's place within the hierarchy. (This is not in itself a cognitively advanced thing to do — chickens do the same (that is where the concept of pecking order came from in the first place!).) Playing back cries of a vervet monkey infant makes the others in the group look toward the child's mother (Seyfarth 1987: 448). Other experimental demonstrations of social concepts in monkeys (mother-offspring, sibling) come from Dasser (1987). Apes also evidently gain knowledge by watching their fellows: 'Chimpanzees may be able to glean a great variety of information about the world by studying the actions of others' (Passingham 1982: 200).

1.5 Deception

Cheating, or feigning, is known throughout the animal kingdom by the name of mimicry and camouflage. Birds of some species will feign a broken wing to get rid of an unwelcome predator, but this is probably a non-conscious, non-cognitive program, rather than problem-solving behaviour. Anecdotal evidence does exist, however, pointing to deliberate, intentional lying among apes and monkeys (Whiten & Byrne 1988).

1.6 Theory of mind

One question is whether the ape itself is an intentional animal, creating and acting on goals; another is whether it treats its fellow apes as intentional. David Premack has answered the second question in a series of experiments by showing that a chimpanzee can treat others as having intentions (Premack & Woodruff 1978). His chimp, Sarah, could watch a videotape of a person trying to solve a problem and then find among alternatives the right tool to solve the problem. Here it is important to remember that the problem could not be described in purely physical terms, so that the chimpanzee could not solve it merely by looking. It had to 'imagine' the person (not another chimpanzee) as having a problem and trying to solve it. Since it did so, we can conclude that the ape has a theory of mind.

1.7 Capable of learning a language-like system?

Apes in the wild do not speak, but several experiments have tried to teach them language (see the short review in Donald (1991: ch. 5)). Although chimpanzees have not been able to learn any sophisticated language (say, beyond the stage of a two-year-old child) they have demonstrated a degree of language capacity by using arbitrary symbols to denote physical objects. Evidently apes can encode mental content into physical tokens (manual signs, plastic symbols, pictograms) but do not have the syntactic machinery for stringing words into sentences. If human language does indeed comprise an innate module for processing syntactic information, it is hardly remarkable that apes cannot do syntactic processing. Otherwise, they would have a complete language faculty that they never use — which is scarcely plausible.

On the basis of these diverse indications of ape intelligence, I conclude that, if language developed from cognition, the ape has the means to fulfill the role, and *so had the last common ancestor between ape and man*.

2 The function of language

The scenario is this: in some distant past (approximately 6 to 8 million years ago) an apelike primate existed which became the last common ancestor between apes and humans. The two lines separated. In one, language evolved, in the other it did not. Why? In the *Homo* line several things happened, while the apes remained relatively static. The ape's brain, for example, seems to have changed and grown very little since the split, suggesting that the ape was already well adapted to the pressures of its habitat. Not so for the line of *Homo*, where many things changed, even though they took several millions of years to happen: upright walking, freeing of the hand and changing manual function (especially of the thumb), handedness, lateralization and rapid growth of the brain, conquest of fire, toolmaking, weapons, changing social structure, culture. All these things surely contributed to the origin of language, and a total account of language origins would have to take all these things into consideration. I have not tried to do that and will not do so here. Instead I have asked why humans, but not apes, have language. This question can be given a plausible answer if we understand correctly the biological role of language. What is its survival value? My answer is that language

had — at the time it began to evolve or get a foothold — the function of communicating thoughts among group members. To use language is to share information as deliberately as the sharing of food is deliberate, and contrasts with the involuntary giving away of information of, say, a monkey displaying that it is scared when approached by an aggressive male.

Not everybody agrees that language has such a function now, or had it then, when it first evolved. Chomsky opposed any fixed function for language, in discussion with Searle (Chomsky 1975). Here I side with Searle, and with the pragmatic and functionalist schools of linguistics (Harder 1996). Language can certainly be seen as a mechanism of thought, but I do not think that function is primary, because it would be much better taken care of by an interior language. Such an internal language, a language of thought (Fodor 1975), may indeed already be in place as a precondition of thinking even in non-human primates (or in every animal able to make inferences?).

If we can substantiate the above functional view, some of the answers to the question of language origin may fall into place. We can ask: why did chimps not get a language? We now know that they have enough intelligence to use simple symbols. Either they did not need a language or they were prevented from getting it. My guess is that they were prevented, because if they had had tasks that would be furthered more easily by having language, such as planning, reporting, discussing, and so on, then the need was there. The need is indeed there today, as is shown by apes patrolling, hunting, moving to new food sites, and so on. We may expect the same need in prehistoric times. So they were prevented — by whom or by what?

3 Sharing of information from a Darwinian perspective

Presumably, language was blocked in the chimpanzee by the impersonal forces of Darwinian evolution. Every trait that enhances one's fitness enhances (by definition) one's chances of survival and chances of reproduction and so of passing one's genes to the next generation. Prima facie, language would seem to be such an improvement for us that we are tempted to extrapolate into thinking that language would be an advantage for every species. Taken out of context — not entirely fairly — Cook (a Chomskyan linguist) says: 'the possession of language itself clearly

confers an immense advantage on its users over other species' (Cook 1988: 23). Chomsky, too, at one time at least, presupposed the advantage of language: 'In some ill-considered popularizations of interesting current research, it is virtually argued that higher apes have the capacity for language but have never put it to use — a remarkable biological miracle, *given the enormous selective advantage of even minimal linguistic skills*, rather like discovering that some animal has wings but has never thought to fly' (Chomsky 1975: 40, my italics).

It is easy to see that this should not be generalized: a bee talking would have such a big head that it could not fly! In other words, having a language is a question of cost and benefit, or, in Darwinian terms, of losing and gaining fitness. We are so used to focusing on the benefits that we tend to forget the costs.

Loosely speaking, some of the costs are: extra brain tissue, reorganization of the brain, changes in the respiratory system, and many more. What are the benefits? The one benefit that we tend to take for granted is that language enables us to co-operate, to speak to and help each other. From a Darwinian perspective, this is also, paradoxically, its main cost. In fact, on the face of it, language as a means of giving information away, would scarcely seem to be *an evolutionarily stable strategy* (Maynard Smith 1982). Why should we share information in the first place, if evolution demands that we enhance *our* fitness, not our neighbours'? If we look at animal communication, it seems that most of it has a selfish purpose. If territorial songs are an easier way of keeping competitors away, it seems preferable to patrolling and beating up other male conspecifics (Krebs & Dawkins 1984). Mating calls have a similar selfish purpose. Warning calls, on the other hand, seem to break the rule. Yet even here, without having investigated the matter thoroughly, we may suppose that the concept of *inclusive fitness* can explain the phenomenon. Helping offspring and related family is more important for fitness than the loss of fitness due to helping competitors in the same group. Perhaps indeed selfishness has kept animal communication at a minimum. Wilson (1972) finds the static nature of animal communication striking:

'By human standards the number of signals employed by each species of animal is severely limited. One of the most curious facts revealed by recent field studies is that even the most highly social vertebrates rarely have more than 30 or 35 separate displays in their entire repertory' (p. 56). It is striking indeed: both compared to human language and to the evolution of intelligence.

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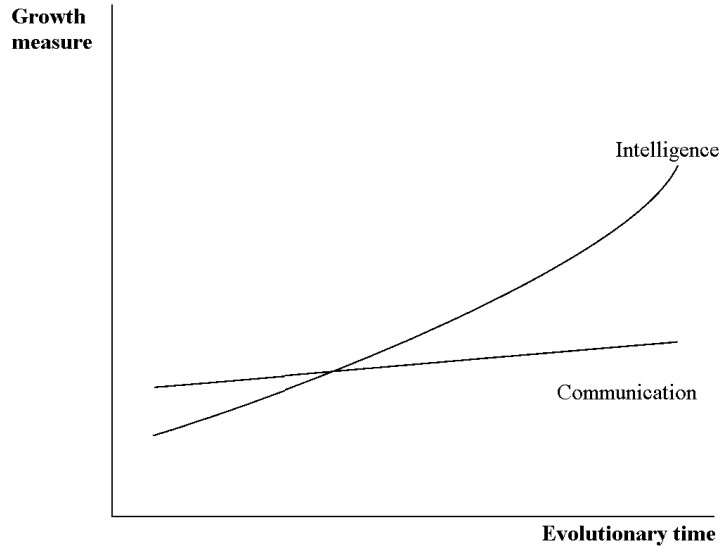

Figure 3.1 The evolution of animal communication and intelligence across species.

My conclusion from this is sketched in Figure 3.1. Evidently the advantage of intelligence is such that a selective pressure toward its increase has been steadily maintained over evolutionary time. Not so for communication, which has been static and without extraordinary selective pressures. So perhaps, we may speculate, communication has been constrained within narrow limits because a selfish animal has very few things that he wants to communicate. But with intelligence it is the other way around: extracting important information from the environment (including the social surroundings) can be increased without limits because cognition can be inherently selfish. Insofar as intelligence entails coping with information it would seem to be the 'natural' course of things that animals should become increasingly intelligent. Language, from the same perspective, is not part of the 'natural' course of things: sharing information is an altruistic act and should not occur according to standard Darwinian theory. How can this paradox be resolved?

4 The last obstacle

To co-operate, as we all know, is often more efficient than letting each work on his own. But working together and cheating the others out of

their fair share is even better — except for those who are cheated. For them, once bitten, twice shy — which argues against doing co-operative work after all. This dilemma is known as the *Prisoner's Dilemma*, a dilemma imposed by the principles of Darwinian selection. Perhaps indeed this is why language is not so widespread across species: if it is better to lie than to tell the truth, why do all this elaborate coding of thoughts into speech against which an effective strategy is just not to listen?

Luckily, we have a loophole: *reciprocal altruism* (Trivers 1971). Through reciprocal altruism, co-operation becomes possible, but at a price, the price of keeping track of cheaters and freeriders. Once a cheater, always a cheater, seems to be the harsh law that animals impose. The good side is that a favour is returned by another favour, a friend can always trust a friend. The point is that, although some form of reciprocal altruism is found in many species, including primate species, it is of particular and fundamental importance to the working of a social system based on co-operation. Trivers says this on the evolution of reciprocal altruism:

> During the Pleistocene [3 million years ago], and probably before, a hominid species would have met the precondition for the evolution of reciprocal altruism: long lifespan; low dispersal rate; life in small, mutually dependent, stable, social groups; and a long period of parental care. It is very likely that dominance relations were of the relaxed, less linear form characteristic of the living chimpanzee and not of the more rigidly linear form characteristic of the baboon. [Trivers 1971: 45]

If one looks at today's Bushmen or other stone-age societies, one sees that they are even more egalitarian than a group of chimpanzees (Turnbull 1964). In fact, if it was not for the social structure of the chimpanzees, perhaps they would have language, too. But the impetus for sharing information is small in chimpanzee society, except for occasional sharing and reciprocal altruism based on friendship. As Jane Goodall observed, young chimpanzee males have the patience and ingenuity to open boxes of bananas laid out by researchers, but the older and stronger males take the bananas, leaving little incentive for the youngsters to go on (Goodall 1972).

So this is the whole story: language is cognitive whereas animal communication is not. Cognitive intelligence is an earlier and more widely spread property of mind than language because evolution selects for effective information gathering. Language's proper function

is to communicate, which here means sharing of information. But information-sharing would seem to be prohibited by natural selection, except in extraordinary conditions. Only under the extraordinary conditions of reciprocal altruism can information-sharing take place without loss of fitness to the speaker. In the human lineage, social co-operation based on obligatory reciprocal altruism has evolved, a system which rewards people for co-operating and punishes them (morally and physically) for cheating. In such an environment language is finally possible.

5 Conclusions

1 Language evolved, by a wholly Darwinian process, out of animal cognition, not out of animal communication.

2 The function of language in modern *Homo sapiens* and in the species' language-using ancestors is to communicate thoughts.

3 In so far as language entails sharing information, it might be considered disadvantageous to the individual, while cognitive intelligence is clearly advantageous. Accordingly, intelligence is the rule across species, language the exception.

4 Language evolved in the *Homo* lineage not because of superior hominid intelligence, but because of special social conditions: the development of reciprocal altruism as a way of gaining fitness by sharing and helping.

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References

Bickerton, D. (1990). *Language and Species*. Chicago and London: University of Chicago Press.

Chomsky, N. (1972). *Language and Mind*. (Enlarged edition) New York: Harcourt Brace Jovanovich.

----- (1975). *Reflections on Language*. New York: Pantheon.

----- (1980a). Discussion. In Piattelli-Palmarini, M. (ed.) *Language and Learning. The Debate between Jean Piaget and Noam Chomsky*. London: Routledge and Kegan Paul: 73-83.

----- (1980b). *Rules and Representations*. New York: Columbia University Press.

Cook, V.J. (1988). *Chomsky's Universal Grammar: An Introduction*. Oxford: Basil Blackwell.

Cosmides, L. & Tooby, J. (1987). From evolution to behavior: evolutionary psychology as the missing link. In Dupré, J. (ed.) *The Latest of the Best. Essays on Evolution and Optimality*. Cambridge, MA: MIT Press.

Dasser, V. (1987). *Social concepts of monkeys*. Ph.D. Zurich: Zentralstelle der Studentenschaft.

Donald, M. (1991). *Origins of Modern Mind: Three Stages in the Evolution of Culture and Cognition*. Cambridge, MA: Harvard University Press.

Engelsted, N. (1984). *Springet fra dyr til menneske* ['The leap from animal to man', in Danish]. Copenhagen: Dansk Psykologisk Forlag.

Fodor, J. A. (1975). *The Language of Thought*. Hassocks, Sussex: Harvester Press.

Goodall, J. (1972). *In the Shadow of Man*. London: George Weidenfeld and Nicolson.

Harder, P. (1996). *Functional Semantics*. Berlin: Mouton de Gruyter.

Horgan, J. (1995). The new social Darwinists. *Scientific American*, 273(4), 150-157.

Krebs, J. R. & Dawkins, R. (1984). Animal signals: mind reading and manipulation. In Krebs, J. R. & Davies, N. B. (eds.) *Behavioral Ecology: An Evolutionary Approach*. (2nd edition) Oxford: Blackwell Scientific Publications: 380-402.

Linden, E. (1986). *Silent Partners. The Legacy of the Ape Language Experiments*. New York: Ballantine Books.

Maynard Smith, J. M. (1982). *Evolution and the Theory of Games*. Cambridge: Cambridge University Press.

Menzel, E. W. (1978). Cognitive mapping in chimpanzees. In Hulse, S. H., Fowler, H. & Honig, W. K. (eds.) *Cognitive Processes in Animal Behavior*. Hillsdale, NJ: Erlbaum: 375-422.

Passingham, R. (1982). *The Human Primate*. San Francisco: W. H. Freeman.

Pinker, S. (1994). *The Language Instinct*. New York: Morrow; London: Penguin.

----- & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Sciences*, 13, 707-784.

----- & Prince, A. (1988). On language and connectionism: analysis of a Parallel Distributed Processing model of language acquisition. *Cognition*, 28, 73-193.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences*, 4, 515-526.

Roitblat, H. (1987). *Introduction to Comparative Cognition*. New York: W. H. Freeman and Company.

Rumelhart, D. E. and McClelland, L. J. (1986). On learning the past tenses of English verbs. In Rumelhart, D. E., McClelland, L. J. and the PDP Group (eds.) *Parallel Distributed Processing: Explorations on the Microstructure of Cognition*. Cambridge, MA: MIT Press.

Saussure, F. de (1966). *Course in General Linguistics*. Translated by Wade Baskin. New York: McGraw-Hill Book Company.

Seyfarth, R. M. (1987). Vocal communication and language. In Smuts, B., Cheney, D. L., Seyfarth, R. M., Wrangham, R. W. & Struhsaker, T. T. (eds.) *Primate Societies*. Chicago: University of Chicago Press: 440-451.

Tolman, E. C. (1932). *Purposive Behavior in Animals and Men*. New York: Century.

----- (1948). Cognitive maps in rats and men. *Psychological Review*, 55(4), 189—208.

Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology*, 46, 35-57.

Ulbaek, I. (1990). Why chimps matter. [Commentary on Pinker, S. & Bloom, P.: Natural language and natural selection] *Behavioral and Brain Sciences*, 13(4), 762-763.

Whiten, A. & Byrne, R. W. (1988). Tactical deception in primates. *Behavioral and Brain Sciences*, 11,233-273.

Wilson, E. 0. (1972). Animal communication. *Scientific American*, 227(3), 52-60.