RECONSTRUCTION OF THE MAJOR FACTORS IN THE EVOLUTION OF HUMAN BEHAVIOR

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Abstract

We attempt to review the most significant stages of human behavioral evolution from the time our line of ancestors have separated from the chimpanzees to the last few thousands of years. The emergence of human behavior is not traced back to the effect of one single intrinsic or extrinsic factor, rather to a number of species-specific traits, which, in interaction with one another, form a complex of human behavior. Part of these traits is in connection with group structure, synchronization of behavioral patterns, and the constructional ability of humans. We believe that the evolution of human culture can only be assessed through a systemic approach, the outline of which we have described below.

The classical line of research in humane sciences deals only with a few thousand years of recent history, and the knowledge of even these relatively few years is somewhat imperfect. However, we know from the findings of evolutionary biology that the biological factors of behavioral traits that are so characteristic to humans have evolved and crystallized in a period prior to known history, one that lasted for millions of years. It might prove to be more fruitful to try and solve, or at least view, the problems of humans living today by taking these traits into account. In fact, such work has already started. With the cooperation of anthropology, human ethology, psychology, and evolutionary sciences, we now can attempt to reconstruct the long journey from the time we have departed from our nearest relatives, the chimpanzees, right to the time when evidences of human civilization and culture appeared en masse, about 40–50,000 years ago (Csányi 1979, 1980, 1989, 1992a, 1992b, 1992c, 1996, 2000; Donald 1991; Dunbar 1996; Reynolds 1993; Mithen 1996; Sober & Wilson 1998).

In this evolutionary process, humans have acquired a set of new, species-specific, genetically determined behavioral traits, which are exclusive to them in the whole animal kingdom, and which fundamentally influence their social behavior.

Species-specific human behavioral traits

In the science of biology there is a remarkable significance attached to the concepts of *homology* and *analogy*, since these concepts enable us to deal with various kinds of similarities and differences (Riedl 1978). Very similar traits can result from evolutionary analogy and homology, but while in the case of analogy this similarity is solely due to the identical environmental factors, in the case of homologous evolution the two similar traits (or complexes of traits) share the same structural origin. The coupled concepts of analogy and homology are also helpful to ethologists, when deriving consequences from the comparison of the behavior of different species. Nonetheless, homologies can be very deceitful, since they can cover up those behavioral mechanisms which have evolved as a result of new constraints.

Attempts to reconstruct early human behavior usually try to deduce some important steps of human evolution from studying the behavior of our closest relatives, the primates, mainly chimpanzees and bonobos. This line of research deals with the *homologies*, which can naturally bare very high significance in such a reconstruction (Csányi 1999).

Our nearest animal relatives are the chimpanzees and the bonobos, a species that has departed from the chimpanzee line about two

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million years ago (Waal & Lanting 1997). The genetical information of human and chimpanzee cells differs only by one percent. Chimpanzees' and humans' common ancestor, and our ancestors who lived after the point when the human line separated from the chimpanzee line, were all socially highly developed creatures. They lived in loosely knit groups, which occupied large areas, and they cared for their offspring for a relatively long period. This loose structure of the group, which is also characteristic to chimpanzees, generally means that each member searches for food individually, they constantly compete for the resources, thus they are considerably aggressive towards each other, but on the special occasions of protecting territory, hunting, or keeping predators at bay, they are capable of common action, and at those times they tolerate the company of one another. However, common action only makes up very little of their daily activities. They sleep alone, and they try to consume their food alone. The exception from this is the mother-offspring relationship, which is very close, lasts for a number of years, and involves the sharing of food and sleeping area.

We know quite a lot about the morphological and behavioral evolution of the *homo* lines, which have departed from the chimpanzee line about 6–7 million years ago. We are sure, that by about 3.5 million years ago, they were bipedal walkers, who used tools, and were living in smaller, close-knit groups of about 100–150 individuals. Their further evolution brought about their competence in language and their skill of developing culture (Mithen 1996).

We are convinced that the biologically-based behavioral traits of humans have surfaced in the course of a coevolutionary process, in which there was a constant interaction between the developing culture and the actual, but variable biological bases, the genes. In other words, after the emergence of even the slightest traces of culture, further genetical changes were influenced by selectional pressures of the cultural environment. The moment some of the traits that enable culture formation appeared, even in their proto-form, the moment that these established any kind of cultural structure, the environment in which a certain genetical change was evaluated had been instantly altered (Donald 1991). The capability to form culture is more and more effective in altering the original biological environment, thus fundamentally determining the direction of selection.

The interaction of genes and culture is well recognizable when we try to summarize what species specific biological traits have evolved in humans during this process, which lasted probably for several millions of years (Table 1).

One component of these complex of behavioral traits has evolved in connection with living in groups. In case of animals that live in groups, the size of the group is fundamentally determined by the structure of resources found in their environment. The upper limit of group size is enforced by the fact that each member has to find sufficient food in one day, while the lower limit is determined by protection provided by group density, namely the kind of predators endangering the members, and the means of escaping them. On the other hand, the extent of competition inside the group is also crucial. A very good example is the group structure of baboons and chimpanzees. Baboons, being smaller in body size, need less energy, but for the same reason they are more vulnerable to attacks by predators, so their groups are generally larger, with about 60–80, or even more members. Competition between the members of the group is fierce, so the animals keep larger distances from each other while feeding, but the group quickly closes itself in case of danger. Chimpanzees are larger in body size, so they individually require more food. On the other hand, there are very few predators endangering them, since they live in the canopy of trees. As a result of these factors, their groups are much looser in structure, and consist of fewer members. These groups usually only come together for a small part of the day, mainly after their first morning feeding session, for social activities. The demand of individual search for food, the relatively high level of aggression within the group, and the little danger of predators have determined a smaller group size. Baboons do not have a permanent territory, because they have to cover long distances in order to fulfill the nutritional needs of their large group. Chimpanzees also need a large area, since they are bigger in body

size, needing more nourishment. The males are capable of defending this large territory, but inside it the animals do not have a permanent place of residence, the individuals spend each night at a different spot, by themselves.

Table 1. Species-specific human behavioral traits

Behavior towards group members	**Synchronization of group activity**	**Constructive abilities**
Group individuality	Empathy: emotional synchronization	Mimics (communicating through facial expressions, about 250 different messages)
Dependence, need for contact	Hypnosis: controlled synchronization of behavior	Miming (memory recalled by internal stimuli), motor concepts
Decreased and regulated aggression inside the group	Rhythm, song, music, dance: emotional and behavioral synchronization	Using language • Spoken language: open communication • Naming, description, linguistic constructions
Group loyalty and xenophobia	Imitation: spontaneous synchronization of behavior	Construction of objects • The use and making of objects • Objectivization of abstractions • Logical organization, machines, technology
Members dominated by status and by rules	Education, teaching and discipline	Construction of actions • Individual and group activities • Complementary cooperation • Action plan – Idea – Logical organizations
The triple function of sexuality, couple bonding	Following of rules	Social constructions • Kinship systems, social functions, social and political institutions, religions
Parental care	Rituals	
Socialization		

During the course of human evolution, the group size grew conspicuously. In the first phase of cultural evolution, at the time group-societies evolved, groups were estimated to have around 100–150 members, including situations of danger (Dunbar 1996). Also, the fact that these groups had a camp-like, relatively permanent place of residence can be demonstrated. This increase in group size and a permanent place of residence require a number of conditions to be fulfilled, as well as having several consequences.

The first and most important condition is that in order to have a tightly structured group, within-group aggression has to be minimal because a high level of aggression between members will spread the group. Human ancestors had to bear the close proximity of each other, so they had to eliminate those sources of conflict which lead to high aggression situations in related species. The most important aggressive situations are generally in connection with sexuality and the distribution of food. In contrast to related species, humans are willing to share their nourishments. This fact has been scientifically proven by numerous experiments and observations on chimpanzees, gorillas, and human children. Our species, similarly to other highly social predators, such

as the canines, is capable of cooperative behavior in acquiring and distributing food. The division of nourishments was also facilitated by the fact that if a larger group had permanently settled in a particular place, resources became scarce in the close proximity of the settlement. In order to provide sufficient nourishment for a lot of individuals, a practice of labor-sharing had to evolve, thus not all the members had to engage in the acquisition of food at all times. The need for labor-division has been further enhanced by the fact that the basic forms of food division and taking up permanent residence provided favorable circumstances for a longer period of infant care and socialization. Naturally, one can also reason the other way around. It is well possible that the infants' need for a prolonged period of parental care was the reason why the division of food became necessary. Evolutionary logic is never linear, rather it is always circular, thus both arguments can be accepted separately or together. However, the low level of within-group aggression walked hand in hand with an escalating level of aggression between groups and xenophobia. Signs of these traits can be already observed in the relatively primitive groups of chimpanzees (Goodall 1965).

The second condition which is necessary for a tighter group structure to evolve is the reduction of sexual rivalry. If this level remains high, the continuing quarrels tousle the group, and do not allow for labor-division, since the small hunting parties of males are unable to temporarily leave the group unattended. To solve this problem, polygamy that is typical in the case of our ape relatives gave way to monogamy and a strong bonding of couples, which was made possible by multiple functions of sexuality.

Human sexuality took up the roles of strengthening the bond between couples and being a source of pleasure, as an addition to the original role of producing offspring (Csányi 1999). This change can be observed in the case of the bonobos. Their groups are much tighter than chimpanzees', are based fundamentally on female coalitions, the level of aggression between males is much lower, and the willingness to mate is exceptionally high. Unlike chimpanzees, female bonobos are ready to mate even when they are not in oestrus, although on such occasions much more courting is necessary from the males, and often some "present", such as prized food, is also required. The bonobos' sexual activity is a way to relieve stress, a playful act, which brings pleasure. Homosexuality is quite common in both sexes, together with sexual activity with youngsters (Waal & Lanting 1997).

Sexual psychology holds that in the case of humans the pleasure providing function of sexuality brought about stronger bonding between couples. Human sexuality makes the relationship of the couple stronger, and establishes a longer or shorter period of monogamy, which minimizes sexual rivalry. The hunting males of the group can safely leave for longer periods of time, since they can more or less trust that there is a strong bond between them and their mates, thus their genetic interests are, at least at the statistical average, not compromised.

A new trait that is very characteristic to human groups is group *loyalty*. For animals living in a group, their relationship with their groups is unequivocally determined by the relationships with individuals in the group. The animal mind, as far as we know, is unable to imagine the group as an existing entity which is independent from its members. The exceptional ability for abstraction, which the human mind has, enables just that. People think of their social groups as separately existing, abstract entities, as social constructions, seemingly independent from them. The unconditional loyalty to the group is a new trait to human motivational systems, which is very strong if group members are perfectly socialized in the group. Humans sometimes sacrifice their lives for their groups; they help their fellow members even to their own disadvantage, if necessary. All these are characteristics which are unknown in the animal world. Animal parents may help their offspring, males are ready to protect females, but all this is very limited and serves genetic interests that can be well calculated. As an addition to genetic interests, humans also feel an unconditional loyalty towards the abstract entity of their group, and this will become a fundamental trait to our behavior biology.

In yet another group of new features we can find seemingly very different traits, such as the use of language, the making and using of objects, and abstract thinking. Although they seem different, they can all be traced back to a special kind of open constructional ability, which existed in the animal kingdom only in proto-form before human times. Animal communication is not a system designated to convey thought, rather a physiological control mechanism that serves the synchronization of inner states (Csányi 1994).

The function of human language is considerably different. It is not only for the purpose of communicating messages regarding emotional states, but rather it is a medium that is suitable to exchange representations of thought. With its help one can portray present, past, and future, plan, intention, idea, and alternatives in a totally open system, which can theoretically produce an endless number of messages. It is suitable for making incidents, objects, actions, and actors of the environment, including the social group that uses language, acquire linguistic representations, appear in a new structure, and in new combinations as *reconstructions* of reality. Hereby a new, virtual reality comes into existence, in which the characteristics of objects – be those representations of people or things, real or imaginary – are attributed to them by the user of language. The behavior of these linguistic objects is the function of the creative capacities of speaker. Virtual reality broadens the action-space available to the speakers, since the imaginary objects can take up any form and behavior, but at the same time it functions as a boundary, because the objects can only take up those characteristics which the speakers have given them. In this way the human mind is capable of imagining ideal objects and systems, such as a point, straight line, a circle, a plane, or extremes of good and bad. It becomes possible to invent mathematics, and also to imagine a mystical world, inhabited by demons, fairies, and benignant or fearsome gods.

The making of instruments, especially the making and using of tools was long thought of as the single and most important evidence of human superiority. Since then we know that numerous animals use objects as tools, and some of them even make those that they use. A few years ago the animals which use tools were reckoned up, and an amazing 80 species had this behavioral characteristic (Mundiger 1980). Nonetheless, tool use among animals is extremely peculiar. The individuals of a particular species use tools to solve one distinct task. The capability to do this is genetically determined, and at the most, minimally refined by learning. This is clearly not the case in humans, where the making and using of tools is isomorphic with linguistic competence and abstract thinking. This is also some kind of an open ability of reconstruction. With its help we give objects new, previously conceived forms and characteristics; we design their functioning in accordance with a set of logical rules, thus creating new machines and technologies.

The two groups of traits mentioned above are the basis of human group activity, which is fundamentally different from ones found in animal groups and is without premise. The previously outlined capability of reconstruction is a determining biological attribute to humans, and it does not only present itself as an individual characteristic, but also as a group activity. Group activity and some kind of cooperation may also be observed in other, socially highly developed species (Dugatkin 1997). Chimpanzees, and various species from the dog family for example, hunt together, however, all the forms of animal cooperation are lacking the capability of construction. Observation of animal cooperation is limited to some cases, and this behavior is mainly under genetic control, while learning and learned forms of common activity only serve to refine the genetically fixed patterns of cooperative behavior. If we take a closer look at cooperation among animals, we can see that it is a parallel activity, meaning that every individual intends to achieve the same thing, but since there are more individuals in the situation, each of them works on one specific task determined by the situation and the animal's position. They work in close proximity of each other, completing the task that they have the possibility to do.

On the contrary, human cooperation is of a complementary nature, meaning that the job to be done is divided into smaller tasks, plans;

alternative strategies are thought of, and roles are given out before the initiation of a certain process. The smaller tasks are assigned to individuals taking part in the activity, thus their activity is complementary in its nature, serving some common goal previously determined (Reynolds 1993). The cooperation in human groups is characterized by the preliminary construction of an "individual action plan", which in fact leads to the individualization of groups, and the mechanism of group selection. The individual action plan is a linguistic construction, its elements are learned, and so it is fundamentally different from the "genetical action plan" that serves as basis for animal cooperation. It is also typical that humans are willing to position these action plans, and later more complex ideas, in the hierarchy of the group, and submit to not only the dominant group member, but the dominant action plan.

Undoubtedly, the constructional capability, the tight group structure and loyalty to the group, language, and the ability of abstraction give the infinite opulence of individual action plans, and these traits enabled the extreme acceleration of cultural evolution. These traits were accompanied by numerous mechanisms which have also first emerged as biological characteristics in humans, and served to synchronize the activity of group members. If synchronizing mechanisms would not have formed, the highly sophisticated constructional ability of individuals would have been in vain, since the group would have been incapable of common action. There are numerous physiological mechanisms which help synchronize actions, such as our ability to imitate. During imitation we are willing to follow suit of observed behavioral patterns without any reward or reinforcement. Lately, there has been great controversy in scientific literature concerning this question, and there is no consensus on whether or not imitation, in the sense of the above definition, could be demonstrated in the case of animals. It seems that it cannot be, not even in primates, since what we call "aping" seems only to be some kind of recognition of cause and effect relationship between a situation or object and a desirable impact. Animals are capable of recognizing such a relationship, and they find the required action by trial and error. In human culture, imitation according to the strict definition is general.

There has been a lot of discussion about what might be the function of hypnability, which is also a species-specific human characteristic. It seems very probable that this also is some kind of controlled synchronization, in the course of which the hypnotizer guides the action, but he also takes up some patterns of movement and emotion from their subjects (Bányai 1992). Hypnability might be a suitable implement to tightly synchronize the emotions and behavior of group members (Csányi 1992a).

The human skill of readily accepting a set of rules, for example the group norms, also leads to the synchronization of the behavior of group members. Emotional synchronization can be achieved in many ways. People who are capable of the production and the appreciation of rhythm, music, song, and dance, in the course of these activities take part in a kind of mind and behavior synchronization.

Finally, we have to emphasize some peculiar consequences of the interactions of the groups of traits described above. The closely knit structure of groups, the constructive activity, and the skill of synchronization created a kind of feed-back loop. A large proportion of constructional activity of the isolated group is intent on the group itself, which is amplified by synchronization, and conserved by group loyalty and its attendant phenomena, thus the group *constructs itself*. This bares many consequences. One of them is the development of different sets of rules, norms, and superficial structures of language. Just like the child when he is learning to speak is capable of extracting the system of rules which is valid in the given linguistic context (the grammar described by linguists is nothing but a mere scientific model of this), the individual is capable of recognizing a certain system of rules in the behavior and interactions of his fellow members. Due to his further characteristics, he is capable to follow this set of rules, thus strengthening the rules themselves. Language, systems of being related, rites, as well as everyday practices have evolved and have been conserved in culture this way, contributing to group individuality already mentioned. The individuality

of groups is the fundamental condition of processes of group selection, the existence of which has so far only been successfully demonstrated in the human species. The evolutionary processes of human behavior can be discussed and understood only in view of the group selection theory, which fact is now also acknowledged by leading sociobiologists, who have denied the existence of group selection for long (Sober & Wilson 1998).

As we have mentioned before, the highly irreversible process of biological and cultural socialization is very important, in the course of which, during maturation, the member learns the language and customs of his group, his biologically based bonds to group members and to its global ideas form, and he develops unconditional loyalty to his group. If the individual is born into an optimally sized, isolated group, and such was the case most of the time during human evolution, socialization becomes perfect. No objections could emerge in the questions of global ideas, loyalty, and common actions, since everyone, parents, relatives, and every adult member of the group shared the same views and customs. This socialization process fixed group structure and its higher structures, so the group could only change in very little steps, through many generations, because great changes are not permitted by the process of socialization.

System-generating attributes

If we examine the new biological characteristics from the view of the relationship between human individuals and their group, we will find that essentially four significant changes occurred:

1. The formation of *common believes* in human groups. Humans accept, wish for, and believe without criticism the cultural conceptions, myths, religion, ideology of their group, the parts of culture expressing identity.
2. Humans became capable of *common action* with members of their group. They are capable of high level, complementary cooperation in the framework determined by cultural conceptions.
3. Cultural ideals and culturally controlled actions continuously bring about *common constructions* in the material and social world, as well as in the world of language and thought.
4. Humans establish a strong *emotional bond* with their group, and for the sake of their group, unlike animals, people are willing to show behavior totally conflicting with their own genetical or individual interests, even as far as sacrificing themselves.

Some of these traits described above have been also found by Durkheim, in his studies of primitive religions (Durkheim 1961). These four traits essentially correspond to humans' special, congenital ability for system generation. From the aspect of behavioral biology, this system-generating ability is a fundamental characteristic of humans as species. All human culture is a highly integrated system of people, objects, forms of behavior, and ideas. These different components are organized and integrated into human culture by this system-generating ability.

Behavior analogous to human behavior in dogs

So far, science has used primate homologies to reconstruct human behavioral evolution. If we could find a species in which analogies to human behavior could have been demonstrated, the study of this species would contribute significantly to this reconstruction, since analogies show the characteristics of evolutional constraints more accurately than homologies, especially if the species is only very distantly related.

The basis of my recent years of research regarding dog behavior is the hypothesis, that dogs' environment today shows numerous similarities with the environment of early, maybe pre-lingual humans. Both environments consist of organized communities of humans, with members who are cooperating, communicating in some way and are keen to understand each other's mental states and social actions. I assume that this environment influenced selection in both the evolution of early humans and in the processes of dogs' domestication. If this is a viable hypothesis, than studying the characteristics of dogs could

serve as a model by which one can study early human evolution. If our research confirms that dogs and people show certain behavioral analogies, then we can assume that connections between some of the elements are not accidental, rather there is some kind of important mechanism of behavioral evolution behind them. So by watching dogs, we can learn important things about humans, about the early stages of development in human behavior in particular. Based on DNA studies it can be presumed that dogs have lived by the side of humans for 130–150000 years, so there has been sufficient time for the species to adjust to human environment genetically (Vilá *et al.* 1997). If essential components of the human behavioral complex can be demonstrated in dogs, we might have a chance to see those functionally coherent mechanisms more clearly which have emerged through evolution as an effect of the human way of life. The relevant components of the human behavioral complex from the aspect of the study of human–dog behavioral analogies are listed in Table 2.

Table 2. The minimal components of the human behavioral complex.

Social attraction and close group structure
Cooperation
Lowered level of aggression
Social understanding
Social learning
Rule following, rites
The need to communicate: signs, rites, miming, language

The certain elements of this *minimal complex* are in close connection with each other, this is another reason for their distinction. For example, close group structure and strong social attraction required for its formation can only evolve in a species which is not highly aggressive towards fellow group members. If the tight structure of the group is already established, social understanding becomes very important for the individual, so he will be able to comprehend what his fellows think or plan. A large group, the members of which are together at all times, can only stay together if the members are capable of common action in the provision of food, meaning some kind of cooperation, and they are also able to share the acquired goods without substantial aggression. It is also very important for such a group that the motivations and emotional states of its members are in synchrony. Empathy, unknown in the animal kingdom, rule-following, as well as rites, serve just that. Human language probably became part of the complex much later, since we know of numerous much simpler communicative mechanisms, not found in animals, for example miming and communication through facial expressions.

During our experimental work we searched for evidences of human–dog analogies of the above minimal components by studying dogs, wolves, and children aged 3–12 years, and we have published the acquired data in numerous reports. Here I would only like to mention those of the highest significance.

The following notable changes in behavior have been demonstrated in dogs:

1. Dogs became more inclined to socialize with members of a different species (humans). sensitive periods during maturation are less pronounced, life-long bond between humans and dogs appeared. According to our studies, the bond between dog and owner can be measured by a method used in human psychology for parent–infant relationships (Topál *et al.* 1998). Further research indicates that the bond to humans is a fundamental need of dogs. If we deprive them of the possibility of social contact with humans (for example in a dog-shelter), they respond with an increased need for human contact, which is manifested in the extremely fast establishment of attachment, when chance is given (Gácsi *et al.* 2001). The concept of this unusual bond between dogs and humans is further affirmed by the ongoing research on the behavior of tame wolf pups which were raised by humans. We are studying the behavior of 5–6 weeks old wolf and dog puppies, raised under identical conditions, in a situation in which they had to make a choice between their

owner and a stranger. Dogs' latency of the approach of the owner is significantly lower, and the time spent in the owner's proximity is longer than these same values in the case of the wolves. If the choice is to be made between a strange person and a strange dog, dogs choose the person, while wolves choose the dog. Thus the first evolved analogy that seems highly probable according to our research is *special attachment to humans.*

2. Phenomena implying highly developed inter-specific cooperation. An increase in the controllability of behavior (self control and control by others) can be demonstrated (Topál *et al.* 1997). The study of cooperation in working dogs proved to be quite fruitful from the aspect of the discovery of analogies. We have found by studying guide dogs for the blind and their owners that guiding is a very sophisticated cooperative activity, involving the intent contributions of both parties. A very important element of this cooperation is the constant shift in the dominance in decision making, in the course of which sometimes the dog is the one initiating the course of action, and some other times it is the owner who decides what will happen next. The individual dog-owner pairs taking part in the experiment were considerably different in the proportion of decisions made by dog or the owner, but the shifts in dominance imply that dogs and people are capable of synchronizing their action in a way that is unique in the animal world. The scientific data was gathered from the study of skillful dogs and owners (Naderi *et al.* 2001). Based on this data the second analogy can be drafted: *Significantly lower level of aggression towards members of the group and the ability to shift dominance.*
3. Different forms of social learning have emerged in the inter-specific relationship between dogs and humans: social anticipation, learning through observation, and cooperation with humans. The various forms of social learning are very important synchronizing mechanisms in human cooperation. According to our studies, dogs are capable of effective learning by observation with the participation of their owners as demonstrators (Kubinyi *et al.* in press). The results were similar in the "detour" task conventionally used in behavior science. The latency of solution was significantly shorter in those groups in which dogs had the opportunity to observe the behavior of a human demonstrator (Pongrácz *et al.* 2001a).

   Besides the above examples of social behavior and social learning, we have studied the phenomenon that dogs are able to recognize rules of behavior in certain situations and to adapt and adequately use those rules under conditions entirely dissimilar to the classical social learning situations (Topál *et al.* 1999). It is safe to assume that even this element of the human behavioral complex has emerged in dogs, since their capabilities, forms of behavior, and control mechanisms of behavior were subject to intensive, directionally "anthropomorphic" artificial selection. Dogs, as well as humans, could be capable to recognize behavioral rules in complex social situations, and to use those in order to find certain solutions which both live up to the expectancies of humans, and are not sources of conflict. The following of rules can be well observed in human rites. Personally specific rites can be established in the day-to-day life of dogs as well (Csányi 2000).
4. The changes in cognitive structures primarily affected the communicative abilities and socio-cognitive capabilities of dogs. Since the complex human environment has been an important factor of the behavioral evolution of dogs, it can be assumed that dogs became selectively sensitive to certain human communicative gestures (data implying this result can be found in Miklósi *et al.* 2000; Soproni *et al.* 2001), as well as human speech (Pongrácz *et al.* 2001b), and as a consequence emerged capabilities that help dogs to understand a large part of social situations.
5. In human interactions, providing information is a very important behavioral mechanism. The providing and the understanding of information are vital. The contradictory result of primate research in this field are largely due to subjects' different level of socialization to humans,

and they have to face the criticism that some communicative behaviors of primates socialized to humans in artificial environments are not interpretable under natural conditions, thus they are "artifacts" (Tomasello & Call 1997). This problem can be avoided by choosing dogs as subjects, the reason, among many, being that the study of communicative abilities of dogs may shed some light on special adaptation mechanisms.

During our research we have studied dogs' capability to identify and use different human gestures indicating the location of reward in a search task. We have found that they are instantly, or after just a few trials, capable of correctly interpreting not only the pointing, leaning or nodding gesture, but also the much more subtle gesture of the movement of the human eye (Miklósi *et al.* 1998; Soproni *et al.* 2002). In this respect they achieved much better results than monkeys trained in similar situations (Anderson *et al.* 1995), their achievements are only comparable to those of the great apes, but even exceed those. Ongoing research shows that wolves are not capable of similar achievements, so this capability in dogs is a result of domestication.

6. Under more complex experimental conditions we can demonstrate that dogs are able to comprehend the possible mental states of the person cooperating with them. The above described studies and many others affirm that the *exchange of information between dogs and humans* can also be categorized as forms of analogies in behavior.
7. The most highly developed form of social understanding has evolved in humans through linguistic competence. It requires lots of further work and complicated experiments to study the level of understanding of vocal, linguistic signs in dogs. Apparently, dogs do not have a competence in language, but it seems probable that due to their highly developed social intelligence, they achieved more than being simply conditioned to signals in their understanding of words and commands (Pongrácz *et al.* 2001b).
8. In our latest experiments, currently in preparation, we successfully demonstrated that dogs could be easily persuaded to functionally imitate human behavioral patterns (Miklósi *et al.* in preparation), which probably can be achieved due to dogs' developed social understanding.

Conclusions

The results of several years of scientific work affirm our initial hypothesis: certain behavioral analogies can be demonstrated between humans and dogs, and these are the following:

1. Special attachment to humans
2. Complementary cooperation with shifting in dominance
3. Social learning
4. Rule following, establishment of rites
5. Information exchange
6. Rites as a proto form of communication
7. Highly developed social understanding
8. Functional ability to imitate

Based on the emergence of behavioral analogies, the early, pre-lingual phase of human behavioral evolution may be modeled. The construction of such a model is in preparation, but as we can see already, the explanation of evolutionary changes in behavior required in the process of becoming humans will not be based on one chosen characteristic, such as competence in language of tool use, rather on more, seemingly less important traits, such as attachment, shifting dominance, social learning, rule following, imitation, and of course primarily social understanding. Social understanding provides a frame for the components described above, could have served as a selectional complex in human behavioral evolution and could have led to the emergence of more complex traits, such as language and culture. If this new finding is valid, our research on dogs has provided important guidelines for its creation.

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