Stories of Lemurs and Robots -

The Social Origin of Story-Telling

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Introduction

This chapter[1] discusses narrative intelligence in the context of the origins of primate (social) intelligence. The relationship between social intelligence and narrative intelligence is outlined, with a particular emphasis on 1) the phylogenetic origins of primate (narrative) intelligence, and 2) the ontogenetic origin of autobiographical stories. The chapter is based on the assumption that in order to fully understand the importance and role of narrative in human intelligence one needs to draw attention to 'where stories come from', i.e. addressing whether story-telling can be linked to communication mechanisms that are evolutionary older but served a similar function, under which conditions and constraints story-telling capacities might have evolved, to what extent narrative intelligence is linked to social intelligence, etc, see Read and Miller (1995). This chapter will address some of these questions on the *origin of narrative* in *primates* and hopes to complement research that focuses on the particular structure and role of narrative in *humans*, e.g. (Turner, 1996). Since the ontogenetic (developmental) aspects of story-telling are discussed in more detail elsewhere, e.g in (Engel, 1995/1999; Nelson, 1986), this chapter focuses on selected research in primatology and autobiographical memory. The *Narrative Intelligence Hypothesis* (NIH) is explained, according to which the evolutionary origin of stories and narrativity was correlated with increasing social dynamics in primate societies, in particular the need to communicate about third-party relationships. Human narrative intelligence might have evolved because the structure of narrative is particularly suited to communicate about the social world, although in present human societies narrative and social-telling is used in a variety of contexts where social matters and communication might not necessarily be central (cf. narrative in arts, advertisement, entertainment etc.). After an introduction and discussion of the NIH, the possible implications of narrative intelligence research for understanding autism, and autism therapy are discussed. It is argued that *narrative technology* can potentially meet the social and cognitive needs of young primate story-tellers. The chapter concludes by outlining requirements for artificial *socially intelligent story-tellers*.

Primate Intelligence: Getting to Know Each Other

Primate societies belong to *individualized societies*. Here we find complex recognition mechanisms of kin and group members. This gives rise to complex kinds of social interaction and the development of various forms of social relationships and networks. On the behavioral level, long-lasting social bonding, attachment, alliances, dynamic (not genetically determined) hierarchies, social learning, development of traditions, etc., are visible signs of individualized societies. In humans, the evolution of language, culture and an elaborate cognitive system of mindreading and empathy are characteristics of human social intelligence in individualized societies (Dautenhahn, 1997). As a consequence of the latter, humans not only pay attention to other agents and their interactions individually (interactions between distinct personalities), but also use their mental capacities to reason about other agents and social interactions.

In primate societies an individual is not only socially situated (being part of and surrounded by a social environment) but also socially embedded (Edmonds & Dautenhahn, 1998), which means that the agent needs to pay attention to other agents and their interactions individually. Particularly, human primates are specialized in predicting, manipulating and dealing with highly complex social dynamics (involving direct relationships as well as third-party relationships); as we discuss below in more detail, they possess language as an effective means of preserving group coherence, *social bonding* (Dunbar, 1993), and communicate about themselves and others in terms of stories. Humans not only deal with very complex relationships but seem to have *mental models* of themselves, others and the social world, cf. (Baron-Cohen et al., 1985), (Whiten, 1991), (Baron-Cohen, 1995). Humans live in individualized societies (as do some other species of birds and mammals). An increasingly complex social field and an increasing need to communicate effectively with each other were likely to have been among the important constraints in the evolution of human minds.

The use of the term 'minds' in this chapter is based on research into *theory of mind* and *mindreading* where people discuss whether and to what extent humans or other animals are able to reflect on their own mental states (e.g. desires, intentions, beliefs) and those of others. Researchers have studied whether human intelligence is particularly specialized in mindreading (Premack & Woodruff, 1978; Povinelli & Preuss, 1995). Minds are certainly attributed to members of *Homo sapiens* (and, as some evidence suggests, several other hominid species might have existed with *minds)*, but other candidates exist among mammals (e.g. non-human apes, dolphins, elephants) and birds (e.g. parrots and members of the crow family). Interestingly, species which we describe as possessing a 'mind' are all highly social. Even the solitary life style of *Pongo pygmaeus* or orangutans, (who nevertheless seem to be highly social in their ability to recognize and interact with each other) is rather a secondary adaptation to a particular environment which demands a spatially distributed social organization.

The *Social Intelligence Hypothesis* (SIH), sometimes also called *Machiavellian Intelligence Hypothesis* or *Social Brain Hypothesis*, suggests that the primate brain and primate intelligence evolved in adaptation to the need to operate in large groups where structure and cohesion of the group required a detailed understanding of group members. For important contributions to the SIH see e.g. (Chance & Mead, 1953), (Jolly, 1966), (Humphrey, 1976/88), (Brothers, 1990), and chapters in (Byrne & Whiten, 1988), (Whiten & Byrne, 1997). This hypothesis does not exclude possibly important ecological variables that might have provided initial demands and might have supported primate evolution. However, it is assumed that social complexity that demanded the evolution of social skills (which allow the interpretation, prediction, and manipulation of conspecifics) has been a prominent selective factor accelerating primate brain evolution, given that maintaining a large brain is very costly. To give an example, an adult human brain weighs about 2 % of the total body, but consumes 20 % of total energy intake, (Aiello & Wheeler, 1995). Identifying friends and allies, predicting others' behavior, knowing how to form alliances, manipulating group members, making war, love and peace, are important ingredients of primate politics (de Waal, 1982). In contrast to strepsirhine primates (lemurs and lorises), monkeys and apes show a variety of sophisticated social behavior: using alliances and cooperation in competition for resources, relying on support by others when acquiring dominance ranks, putting considerable effort into building, reconciliation and maintenance of long-lasting and intensive inter-personal social relationships, knowing personal characteristics and affiliations of group members and using techniques of social manipulation (Byrne, 1999). Note that complex social behavior is also shown by other social non-primate mammalian species. Thus, there are two interesting aspects to human sociality: it served as an evolutionary constraint which led to an increase of brain size in primates, which in turn led to an increased capacity to further develop social complexity.

Dunbar and his collaborators found evidence (cf. (Dunbar, 1992), (Dunbar, 1993), (Barton & Dunbar, 1997), (Dunbar, 1998)) that the size of a cohesive social group in primates is a function of relative neocortical volume (volume of neocortex divided by rest of the brain). Such a correlation has not been found for ecological variables (hypothesizing e.g. that dietary considerations or the size of home ranges caused an increase in brain size). It is therefore suggested that social complexity played a causal role in primate brain evolution, namely that in order to manage larger groups, bigger brains are needed to provide the required 'information processing capacity'. The neocortex, which accounts for 50-80 % of total brain volume in primates, is generally associated with cognitive processes such as reasoning, mental manipulations and consciousness. Compared with more primitive parts of the brain, the neocortex size substantially increases from insectivores to prosimians, anthropoids, and humans. Indeed, it has been shown that primate species with relatively larger neocortices exhibit more complex social strategies than species with smaller neocortices (Pawlowski et al., 1998). It is also suggested that the relationship between encephalization (relationship between brain size and body size) and social complexity is not unique to primates. For example, findings reported in (Marino, 1996) suggest that *cetaceans* (whales, dolphins, and porpoises) and primates show similar relationships between relative brain size and group size (a measure of social complexity). Similarly, Dunbar and Bever (1998) show that neocortex size predicts group size in carnivores and some insectivores. Also, bats that have stable social groups have a larger neocortex than bats that do not live in stable social groups (Barton & Dunbar, 1997).

According to the SIH, primates are good primatologists, namely they are experts on social matters in a *laser-beam* form of intelligence. According to the SIH, during the evolution of human intelligence a transfer took place from social to non-social intelligence[2] so that hominid primates could transfer their expertise from the social to the non-social domain. An interesting aspect of this kind of transfer is discussed in (Mithen, 1996). He explains the evolution of anthropomorphic thinking with an accessibility between the domains of social intelligence and natural history intelligence so that "people could be thought of as animals, and animals could be thought of as people" (Mithen, 1996:224). Furthermore, the accessibility between the domains of social and technical intelligence led to the possibility to think about people in terms of objects to be manipulated, in a similar way as physical objects can be manipulated. Although it is still unknown why hominids needed or chose to live in social groups, this *feedback principle* soon led to the development of highly sophisticated levels of organization and control in human societies, cf. (Russell, 1993).

In non-human primate societies cohesion is maintained through time by *social grooming*. Social grooming patterns generally reflect social relationships:

> "The vervets clearly differentiated between the animals they groomed regularly and those they didn't. A grooming partner is something special, someone who deserves particular attention, who should be supported in moments of need, on whose behalf the taking of risks is warranted." (Dunbar, 1996:22)

Given the neocortical size of modern humans, we can extrapolate from the non-human primate regression and predict a group size of 150 for human societies. This number limits the number of relationships that an individual human can monitor simultaneously, it is the upper group size limit which still allows social contacts that can be regularly maintained, supporting effective coordination of tasks and information-flow via direct person-to-person contacts. Such relationships are *personal relationships*, they have sufficient depth to be relied on, they provide the basis of mutual support and coalition formation that are necessary in cases of attack or the need to access resources. The number 150 is supported by evidence from analyzing contemporary and historical human societies. Dunbar suggests that 1) there is a cognitive limit to the number of individuals with whom any one person can maintain stable relationships (depending on personal knowledge, face-to-face interactions), 2) that this limit (which he terms *cognitive group size*) is a direct function of relative neocortex size, and 3) that this in turn limits group size. But how do humans preserve cohesion in groups of 150 individuals, a function that (physical) social grooming serves in non-human primate societies? In terms of survival needs (resting, feeding etc.) primates can only afford to spend around 20 % of their time on social interactions and social grooming. However, a group size of 150 predicted for humans would require that about 42 % of the total time budget of a human primate are devoted to social grooming. It was therefore suggested by Dunbar (1993) that in order to preserve stability and coherence in human societies, human *language* has evolved as an efficient mechanism of *social bonding*, replacing social grooming mechanisms in non-human primate societies with direct physical contact (allowing only much smaller groups). Following this argument, language allowed an increase in group size while still preserving stability and cohesion within the group.

In the context of the evolution of human intelligence, Richard Byrne pointed out (Byrne, 1997) that the Social Intelligence Hypothesis might account for the evolution of primate intelligence, but offers little explanation for the evolution of specific ape and human kinds of intelligence (e.g. involving mental representations): clear evidence for a systematic monkey-ape difference in neocortex ratio is lacking. Great apes do not form systematically larger groups than monkeys do, which draws attention to physical rather than social factors (e.g. tool use, processing plant food etc.) that drove the evolution of mental representations in apes and humans. Why have in particular human apes evolved sophisticated representational and mental skills, are there any candidate factors that could have accelerated the evolution of human intelligence? Again, it seems most reasonable to start looking for factors in the social field of humans, given the fundamental social nature of human minds and how minds and human behavior develop (e.g. Brothers, 1990; Aronson, 1994). Narrative psychology and studies on the development of autobiographic memory, e.g. (Nelson, 1993; Conway, 1996), and a *self* point towards an important factor, namely that *stories* are the most efficient and natural human way to communicate, in particular to communicate about others (Bruner, 1987; 1990; 1991). According to Read & Miller (1995:139) "Stories are so functional because social interaction is central to human beings, and stories are fundamentally about social interaction…stories are central to the human cognitive system because they capture the essence of social interaction, the structure of human action". Following this line of argument, the *Narrative Intelligence Hypothesis*, (Dautenhahn, 1999c) proposes that the evolutionary origin of communicating in stories was correlated with increasing social dynamics among our human ancestors, in particular the necessity to communicate about *third-party relationships* (which in humans seems to reach the highest degree of sophistication among all apes, cf. gossip and manipulation, (Sinderman, 1982)). As will be explained in more detail below, according to this hypothesis, human narrative intelligence might have evolved because the structure of narrative is particularly suited to communicate about the social world.

An evolutionary trend from physical contact (non-human primates) to language (hominids) to communicating in stories (modern, highly 'enculturated' humans living in complex societies) correlated with an increase in complexity and sophistication of social interaction and mindreading. This trend demonstrates the evolution of increasingly efficient mechanisms for *time-sharing* the processes of social bonding. While physical grooming is generally a dyadic activity, language can be used in a variety of ways extending the dyadic use in dialogues to e.g. one-to many communication as it is today used extensively in the mass media (television, books, email etc.). It has been estimated (Dunbar, 1993) that the human bonding mechanism of language is about 2.8 times as efficient as social grooming (the non-human primate bonding mechanism). Indeed, evidence suggests that conversational groups usually consist of one speaker plus 2 or three listeners. Of course larger groups can be formed easily, but in terms of actively participating and following different arguments within the group 1+2(3) seem to be the upper limit for avoiding information processing overload in the primate social brain. Also, language because of its representational nature affords documentation, preservation in storage media and transmission of (social) knowledge to the next generation, as well as communication between geographically separated locations (cf. (Donald, 1993) for a discussion of language and external symbols in human cultural evolution).

Discussions in the social domain (e.g. on social relationships and feelings of group members) are fundamentally about *personal meaning*, different from e.g. discussions in the technical domain (e.g. about how to operate a tool or where to find food). We suggest that narrative might be the 'natural' format for encoding and re-constructing meaningful, socially relevant information (e.g. emotions and intentions of group members). According to Dunbar (1993) people spend about 60 % of conversations on gossiping about relationships and personal experiences. Humans use language to learn about other people and third-party relationships, to manipulate people, to bond with people, to break up or reinforce relationships.

Thus, a primary role of language might have been to communicate about social issues, to get to know other group members, to synchronize group behavior, to preserve group cohesion. Language is based on representations and the possibility to combine them in arbitrary ways. Representations need not be 'symbols', they can be spatial or visual in nature, and can be verbal or nonverbal. Apes can be trained to a subset of American Sign Language in order to communicate with humans, see e.g. studies with the chimpanzees Washoe and Nim (Gardner & Gardner, 1969; Terrace et al., 1979), the gorilla Koko (Patterson & Linden, 1981), or the orangutan Chantek (Miles, 1990). Alternatively, icon-based keyboards (lexigrams) have been used in human-ape communication, e.g. Savage-Rumbaugh's studies with chimpanzees and bonobos such as Kanzi (Savage-Rumbaugh et al., 1986).

However, as of today, there is no convincing evidence that apes are using a symbolic, representational system in the wild on a level of complexity that can be compared to human language. Non-human apes do communicate extensively with each other, using gestures, vocalizations, eye-contact, and a range of "body language". While these means allow efficiently to communicate about the "here and now", they do not support a broadening of the *temporal horizon* (i.e. communicating about the past, future, (Nehaniv, 1999)), and events and group members that are absent. Obviously, there has not been a strong selective advantage for non-human apes in developing elaborate symbolic representational systems, although primate politics shows that non-primates do take into consideration the past and the future when deciding on how to behave socially, e.g. when predicting the behavior of conspecifics. Thus, non-human apes seem to possess mental representations, but it is unclear whether these representations are symbolic. Therefore, in terms of mental and communication skills humans and other apes have a lot in common, they possess mental representations and communication systems, but only humans possess an elaborate *symbolic/linguistic representational system* that is necessary for communicating via *human language* (cf. (Cheney & Seyfarth, 1990) for discussions on communication systems in vervet monkeys). Interestingly, as Oliphant (Oliphant, 1999) points out, a representational system which can learn word-meaning associations need not be computationally very expensive. Therefore, the information processing capacity of the brain can not be responsible for the fact that humans use language and chimpanzees in the wild do not. However, it is important to note that the form of human languages as such is meaningless. Words and sentences become meaningful only as a result of a cognitive effort that *creates* meaning and puts messages in *context*. The ability to construct and give meaning to representations is a 'computationally' expensive process, e.g. it requires identification and interpretation of the context of the communicative event, such as the personality/character of the sender (is he trustworthy?), the relationship between 'sender' and 'recipient' of a message (potential mate? competitor?), important third-party relationships, positions in the group hierarchy etc. Thus, one and the same 'message' can have potentially many different interpretations and 'meanings', depending on the complexity of the primate social field (discussed below), the number of different roles an individual can have, and the potential to create new roles and relationships.

Although humans use gestures, facial expressions, body language and other non-verbal means to convey (social) meaning, human communication is dominated by verbal communication, which is serial in nature (although in face-to-face interaction accompanied by non-verbal cues). Thus, given the serial communication channel of human language, what is the best means to communicate social issues, namely learning about the who, what, and why? Physical social grooming, the main group cohesion mechanism in non-human primates is 'holistic', parallel, spatial, sensual, meaningful. How can a stream of symbols that are in themselves meaningless convey meaning such as bodily grooming does? I argue that narrative structure seems to be particularly suited: usually a narrative gives a certain introduction of the characters (making contact between individuals, actors, listener and speaker), develops a plot, namely a sequence of actions that convey meaning (value, pleasurable, unpleasurable), usually with a high point and a resolution (reinforcement or break-up of relationships), and focuses on *unusual* events rather than stereotypical events. In this way, stories seem to give language a structure which resembles (and goes beyond) physical grooming, namely replacing physical presence and actions by the creation of a mental picture of physical actions, providing the stage, actors, intentions and a storyline. Story-telling also gives more flexibility than social grooming as to the actors and content of the stories: stories can include people that are part of the current audience, as well as absent persons, historical characters, fictional characters, etc. Stories that are told by a skilled story-teller (e.g. using appropriate body language, exploiting prosody, and possessing a rich repertoire of verbal expressions) can give very good examples of the power of words. The format of a story can provide sensual, emotional, and meaningful aspects to otherwise 'factual' information, e.g. poetry gives numerous examples of stories that can elicit emotional responses and influence people. Thus, both story-telling in humans and social grooming in non-human primates are efficient social bonding mechanisms.

To summarize this section, *narrativity*, the capacity to communicate in terms of stories, is regarded as an efficient means to communicate social matters, and the origin of narratives might therefore have been a crucial milestone in the evolution of primate social intelligence (Read & Miller., 1995:150) "It is because of the social, and the need to effectively manage social interactions, that we developed stories - stories made for the cognitively complex humans that we are. It is our stories that make us human". According to the *Narrative Intelligence Hypothesis* (NIH), the evolutionary origin of stories and narrativity was correlated with increasing social dynamics in human primate societies, in particular the need to communicate about third-party relationships. The evolution of the human story-telling mind was possibly correlated with the evolution of complex mechanisms of social understanding and a complex social field. This suggests that if we intend to develop a socially intelligent agent (Dautenhahn, 1998) which can truly understand and respond to stories in human-agent interaction, then we need to model at least to a certain extent social relationships and primate social life. In the following sections we analyze the primate social field, and in more depth social understanding and the role of narrative in autobiography.

The Primate Social Field

The primate family tree split up about forty million years ago into prosimians, which might resemble early arboreal primates (e.g. lemurs), and anthropoids (monkeys, apes, incl. humans). The problems of social life are especially complex for species whose cognitive skills create a complex *social field* which is based on several fundamental components:

1) Individuals specifically recognize other conspecifics in their groups as inviduals and as kin. Primate societies are *individualized societies*. The social world of primates is primarily vision-dominated, recognition of friends and relatives and their behavior is therefore strongly based on visual cues, e.g. faces need to be recognized and memorised.

Two separate mechanisms have been proposed for kin-recognition: early familiarity (i.e. previous experience with the individuals in question) and phenotypic matching (using visual or non-visual cues). Generally, it is assumed that kin recognition in primates depends on previous experience. However, chimpanzees have been shown to be able to match related but unknown individuals by visual cues, in the same way as humans can match persons in a family album. In the wild, chimpanzees form loosely organized fission-fusion communities where even closely related individuals spend considerable time apart. Under such conditions phenotypic kin recognition could be greatly advantageous. As Parr and de Waal showed (Parr et al., 1999), chimpanzees can perceive similarities in the faces of related but unfamilar individuals, indicating visual kin recognition at a purely phenotypic level. Their results show that chimpanzees can match very well faces of mothers and their sons, but not mother-daughter pairs. This preference might be due to the particular ecological and social conditions of chimpanzee life.

How individual recognition substantially increases social complexity is shown by the following example described in (Philips & Austad, 1996:265):

> "...imagine a social group composed of six individuals, two unrelated sets of three full siblings. Consider an individual within that group seeking to join two other individuals for the purposes of cooperative hunting. With recognition only of group members versus nongroup members, there is only one recognizable hunting group - himself plus two other group members. If kinship were also recognized, then this individual could discriminate between three kind of groups (two fellow sibs, two nonsibs, one sib and one nonsib). If all group members were individually recognizable, our focal individual could potentially join twenty unique groups."

Thus, the more individuals can be recognized, the greater the number of social contexts recognized which can potentially lead to different responses and interpretations of communicated signals. If an animal can recognize group members individually, then it opens up a large set of choices, choices of who to join with, collaborate with, make friends with etc. The animal's situation is then much different from that of an animal that perceives itself as a member of a large anonymous group of (almost) identical group members. Living in an individualized group poses great cognitive challenges and can enhance the richness and diversity of social life in a group.

2) Individuals can understand and predict at least part of the behavior of other animals. Emotional information needs to be processed, in particular they need to recognize and act on cues to other animals' emotional states.

A variety of behavioral and contextual clues are used to predict another animal's behavior. The human ape is possibly the most social animal of all primates, and shows highly complex social structures and organizations. Elaborate mechanisms of social understanding, including sympathy and empathy (discussed below), a rich body language and facial expressions which are used to express internal states, moods etc. facilitate communication. Humans from a certain age on also attribute mental states to others, they possess a *theory-of-mind* (cf. (Leslie, 1987), (Baron-Cohen,

1995)) and can reason about beliefs, desires, wishes and goals of others. The abilities of humans to get along with each other, despite frequent violent encounters, is remarkable. Imagine one hundred chimpanzees, unfamiliar with each other, crowded in a metro coach. Very soon injuries, even deaths of animals are almost certain to occur. However, millions of (human) commuters survive exactly the same scenario day after day. Surviving in large 'anonymous' groups of people is controlled in human society by a number of norms and regulations. Thus, humans can not only understand and predict individuals, they can apply the same mechanisms to a crowd (as a kind of meta-organism).

3) Individuals remember aspects of previous interactions with group members and so form *dyadic, direct relationships* with them.

This involves remembering rank and past affiliations of group members. Even personal histories (e.g. who helped or received help) might be remembered. Cognitive processes of learning and memory make this possible.

4) Individuals need to remember dyadic relationships in the whole group, i.e. interactions other group members have with each other. This allows them to understand the social relationships of others, i.e. their *third-party relationships.* Such relationships need to be recognized and memorized. Individuals need to be able to manipulate information about a set of relationships, e.g. for the purpose of forming alliances or tactical deception.

Kinship (based on certain patterns of association rather than on genetics), friendship (based on relatively recent aggressive or affiliative encounters) and dominance rank are all involved in the most important kinds of relationships recognized by primates. Many other avian and mammalian species are able to recognize individual group mates, remember past interactions with them, and predict their behavior, but it is not clearly established whether and/or to what extent they understand third-party relationships, i.e. relationships that group members have with one another. Enculturated animals (e.g. chimpanzees that grow up in a human family, put also pet animals such as dogs and cats) often show quite human-like social tactics (e.g. deception, cf. (Byrne, 1997)), and they can even show cognitive skills different from their mother-reared cousins (e.g. improvement of imitative skills in enculturated chimpanzees, cf. (Tomasello et al., 1993)). It is at present therefore difficult to compare primate social intelligence with social intelligence in non-primate mammals. For more information on the primate social field see (Tomasello & Call, 1997), (Dunbar, 1998).

In terms of social complexity (and cognitive processes needed to deal with it), the world of an animal which takes into account third party actions is more complex than the world of an animal which only interacts dyadically. The social problems are still greater if an animal takes into account the probable thoughts as well as actions of its partners in interaction (Byrne & Whiten, 1997).

The Social Life of Lemur catta

Here is an example of the social life of a non-human primate. The primate Center at Duke University gives the following information on *Lemur catta*, see figure 1, a prosimian primate unique to Madagascar:

> "Ring-tailed lemurs are found in social groups of 3 - 25 individuals. Females remain in the group to which they were born for their entire lives, while males may change groups when they reach sexual maturity. Ringtail groups range over a considerable area each day in search of food. All group members use this common home range, and groups are often aggressive towards other groups at the borders of these areas. Females are usually dominant to males, which gives them referential access to food and the choice of whom to mate with. (Female dominance in primates is unique to prosimians.) Social bonds within the group are established and reinforced by grooming. Prosimians groom in a rather unique way, all prosimians (ringtail lemurs included) have six lower teeth that stick straight out from their jaw, forming a comb that the animals use to groom their fur and the fur of other members of their social group." (http://www.duke.edu/web/primate/).

Lemur catta is very popular with many people because these creatures are seen as very gentle and 'friendly' primates. According to Jolly (1966), the fact that social lemurs show the usual primate type of society and social learning without the capacity to manipulate objects as monkeys do, might indicate the primacy of social intelligence in the evolution of primate intelligence. Although it is likely that lemurs can interpret a variety of social cues and use body language and social grooming as social cohesion mechanisms, they are not known to be elaborate story-tellers. According to Nelson (Nelson, 1993:12), when human primates are growing up "an important development takes place when the process of sharing memories with others through language becomes available as a means of reinstating memory...Language opens up possibilities for sharing and retaining memories in a culturally shared format for both personal and social functions. Sharing memory narratives is important to establish the new social function of autobiographical memory, as well as to

make reinstatement through language possible." Thus, autobiographical memory as we know it, i.e. human-style autobiographical memory, seems to go hand in hand with the development of language. Lemurs are not likely to be able to communicate with us by telling stories about themselves and others, although their non-verbal communication system might be rich (and, as one can speculate, possibly even have narrative structure (Dautenhahn, 2001)). However, humans interpret the lives of these gentle and beautiful lemurs in the most natural way, namely as stories and tales, and we cannot do otherwise.

Figure 1: Foto of lemur catta, http://www.scz.org/animals/l/rtlemur2.html.

For investigations into animal minds we cannot hand out questionnaires or conduct interviews, information can only be gained via observing natural behavior in the wild and/or conducting laboratory experiments under controlled conditions. Due to the difficult nature of gaining results that can withstand scientific/methodological scrutiny, many issues regarding animal minds (e.g. imitation, empathy, mindreading) are still highly controversial. We cannot directly look into a lemur's mind, neither do we know what kind of stories elephants or *cetaceans* are telling, and what a story could mean to their lives in the first place. However, imagine that young dolphins grow up while being taught the structure of narratives through story-telling, with their parents, peers and relatives, then the structure of these stories can be expected to be well adapted to life and living as a dolphin, and adapted to the structure of the dolphin's mind, and it might turn out not to be compatible to the human mind. The way humans tell stories might only be one instantiation in a huge space of possible story-telling minds, natural and artificial.

Stories, social understanding, and autobiographic agents

Previously we suggested that two mechanisms are important to human social understanding: 1) empathic resonance, the ability to 'open' oneself towards another self, and to re-experience part of the other person's experiences, and 2) biographical reconstruction, the interpretation of another person's behavior and appearance based on the situatedness of another's mind in time and space (Dautenhahn, 1997). The behavior and appearance of any biological agent can only be understood with reference to its history, considering its context, past, present and future situations. This is particularly important for life-long learning human agents who are continuously learning about themselves and their environment and are able to modify their goals and motivations. Autobiographical memory develops during the lifetime of a human being, and the capacity to fully develop an autobiography is not innate. In Nelson's discussion of the social origins of autobiographical memory in children she supports the *social interaction hypothesis*, namely that children gradually learn the forms of how to talk about memory with others, and thereby learn how to formulate their own memories as narratives (Nelson, 1993).

Humans are constantly telling and re-telling stories about themselves and others. Humans are autobiographic agents, agents which are embodied and situated in a particular environment (including other agents), and which dynamically reconstruct their individual 'history' (autobiography) during their lifetimes (Dautenhahn, 1996). The biologist Steven Rose uses the term lifelines in order to refer to a living organism's trajectory through time and space which make each organism an *individual*: "..it is in the nature of living systems to be radically indeterminate, to continually construct their - our - own futures, albeit in circumstances not of our own choosing" (Rose, 1997:7).

Telling (part of) a plausible autobiographical story to others is more than relating a plausible sequence of episodic events; it includes the construction of a plausible story based on one's goals, intentions and motivations. If we listen to a story originating from a completely different cultural background, the main problem of understanding is usually not to figure out what the actors do, but why they are doing it, i.e. understanding their goals and intentions. Once we understand the underlying motivations for their behavior, it helps us to make the link to similar situations which we, the listeners, experienced ourselves. We then might recall events which are from their appearance completely different, but with a similar meaning for us, which allows an understanding on a level of similarity which addresses the experiential, rather than cognitive, aspects of story understanding.

This creative aspect of story-telling, i.e. to tell autobiographic stories about oneself and create biographic re-constructions about other persons, is linked to the empathic, experiential way of relating other persons to oneself. Story-telling is a central mechanism in human social understanding.

Relationship Between Social and Narrative Intelligence: The Case of Autism

I argued above that in human evolution narrative capacities evolved from the need to effectively manage social dynamics, socially bond with others, exchanging information on third-party relationships etc. In this section I discuss that an impairment of narrative skills might contribute to difficulties people with autism have with social relationships.

People with autism have generally great difficulty in social interactions and developing relationships with other people. They are impaired in reading social cues and facial expressions, which makes the human social world around them frightening and unpredictable (Baron-Cohen, 1995), (Trevarthen et al., 1996/98). A variety of therapy approaches are available, and the author is involved in the AURORA project (Autonomous robotic platform as a remedial tool for children with autism, http://www.aurora-project.com/) that develops a mobile robot as an interactive and therapeutic *toy*, (Dautenhahn, 1999a,b), (Werry & Dautenhahn, 1999), (Dautenhahn & Werry, 2000). Figure 2 shows two children with autism simultaneously playing with the robot, part of a series of trials where we investigated the role of the robot as a social mediator (Werry et al, 2001).

Figure 2. Two children with autism simultaneously interacting with the Labo-1 robot used in the AURORA project.

Previously, (Dautenhahn, 1997) I suggested that an impairment of the processes of empathic understanding and biographical reconstruction might contribute to the symptoms which people with autism show, who are generally not able to build up 'normal' social relationships, nor can they show 'adequate' behavior in social interactions (Howlin et al., 1999). People with autism definitely possess strong emotions, but they seem to lack the ability to view other persons as *mental agents*, as opposed to *physical objects*, which is a crucial prerequisite for empathy and attribution of emotions and mental states to other people. Moreover, children with autism generally do not show pretend-play with dolls or stuffed animals.

A set of standardized experiments are usually used to identify autistic symptoms in children, among them experiments in which a particular story is presented and the child has to answer questions about the actors' current beliefs (false belief test). The *Sally-Anne test* (Baron-Cohen et al., 1985) is about two dolls. 1) Sally and Anne are together in a room, 2) Sally puts a marble in a basket and leaves the room, 3) Anne takes the marble out of the basket and puts it into a box, 4) Sally returns. The child is then asked where Sally will look for the marble. This short story can be presented to the children in a variety of formats, e.g. told verbally with/without objects and cartoons, enacted with puppets or human beings etc. Normal children until the age of four and most autistic children (of all ages) give 'Anne's box' as the answer, i.e. they cannot attribute to Sally a different belief then they have themselves (and they know that the marble is now in

Anne's box). Tests like the Sally-Anne test require you to be able to distinguish yourself and your beliefs and perceptions from those of others: what I {know, believe, perceive, feel} is not necessarily identical with what you {know, believe, perceive, feel}. This ability is not innate, children develop this ability during their first years of life. By the age of 3-4 years a child's *theory-of-mind* is usually well developed, while most children with autism will not succeed at this. The term 'theory-of-mind' has recently been replaced by the term *mind-reading*, in order to express that the skill to understand the social world is not necessarily *theory-based* (e.g. based on a set of axioms and logical rules). Moreover, interpersonal processes of joint attention and/or empathy are alternative approaches to understanding autism, see discussion e.g. in (Dautenhahn, 1997). Failure of children with autism to pass the Sally-Anne test has usually been interpreted as a failure in the development of theory-of-mind or mindreading skills, cf. (Baron-Cohen, 1995). However, as I will discuss in this section, an alternative explanation for such a failure, although related to mindreading skills, could lie in a failure to properly interpret, re-construct and understand *stories*, thus indicating an impairment of narrative capacities in children with autism, as suggested by psychologists such as Jerome Bruner and Carol Felman (Bruner & Feldman, 1993).

According to the developmental psychologist Katherine Nelson (Nelson, 1986) children experience their day as a series of scripts (as suggested in (Schank & Abelson, 1977)) and routines which help them to structure their world of experiences and language. Scripts help them to understand what is going to happen and who is going to do what. Nelson's evidence demonstrates the primacy of scripts as an organizing tool for children. However, as Bruner points out (Bruner, 1991), narratives require scripts as necessary background (the *skeleton*), but they do not constitute narrativity itself. Scripts are not *worth telling* unless they include the *unusual*, breaches, violations to the script which make a story interesting. Thus, children only become true story-tellers once they can create and remember stories about the unusual, the specific, events and experiences that contribute to their unique and individual autobiography.

Interestingly, some people with autism show animal empathy (i.e. they can 'understand' the behavior and feelings of animals, (Grandin, 1995)), so a mechanism of empathic resonance (with animals) seems to exist. Moreover, some high-functioning people with autism can learn and train themselves in social behavior to some extent, by learning and applying generic rules of human interaction, although they usually fail to recognize idiosyncratic social cues (i.e. they fail to construct another person's individual biographic history). Thus, we can expect that when people with autism are confronted with a complex 'social story' (enacted by actors in movies or comics, or by normal people in real life), that the more 'human-like' the actors in a story are, the more sophisticated their behavior is, i.e. the more biographical reconstruction of the story is required, the more difficulty people with autism will have in understanding the story.

Children with autism need structure in their lives, they prefer to stick to a fixed daily routine, and they have difficulty to remember and describe what *actually* happened to them, in contrast to what *usually* happens to them. These attributes are reminiscent of Nelson's evidence that the memory of preschool children is structured around the usual, routine episodes, until children become skilled story-tellers. This indicates an impairment of narrative skills in children with autism, in particular those narratives which are special and individual and which contribute to autobiographical memory. One reason for the difficulties people with autism have in relating, understanding and communicating with other people might therefore lie in an impairment of narrative, story-telling skills, i.e. an impairment of the ability to represent the characteristic narrative shape of human action and interaction (Bruner & Feldman, 1993). From early childhood on, through transactions with others, e.g. in mutual imitation games (Nadel et al., 1999), children learn the 'narrative format' of human interaction, an important milestone in the development of a child's understanding of other minds (cf. discussion in Jordan, 1999). Humans are not only *mental agents*, they are agents with a history, autobiographic agents, interlinked with the histories of other agents in the social field. Social understanding requires an autobiographic agent which is able to re-construct its own and other people's experiences, an agent with a history, an agent which has a body as the point of reference which gives a unique perspective on the (social) world, which allows one to generalize from experiences and to reconstruct specific, individual experiences.

Interestingly, Howlin et al. (1999) who developed a cartoon-based practical guide to teaching children with autism to mindread, pointed towards the importance of *social context and history* in teaching social understanding to children with autism: "Understanding - and reacting appropriately to - people's emotions, involves more than the ability to recognize a few clear and relatively simple emotions from pictures and cartoons. Whether a situation is construed as being happy, sad or frightening will depend, not only on the current context but on the past history of the individual(s) involved. Moreover, facial expression alone may not always be a true representation of how someone is feeling - a smile, for example maybe used in a brave attempt to disguise sadness or pain. And, being able to recognize certain unambiguous emotions in other people, may not necessarily help children with autism fully understand or cope with their own emotional responses, especially if these differ from those of others."

How might one help children in general, and children with autism in particular to become skilled story-tellers? Usually, for children growing up in a social context, surrounded and encouraged by story-telling adults and other children, and exposed to a variety of stories that are written, told or performed, story-telling skills are part of normal development (Engel, 1999), without necessarily being explicitly taught. For children with autism, who were not able to follow that

'normal' path that leads to becoming a skilled story-teller, story-telling skills would have to be taught, explicitly, and in this sense 'artificially', i.e. making things explicit that are normally 'picked up' in a social context. For example, parents and peers do normally not tell a child explicitly 'remember this', 'don't remember this'. The autism researcher Powell (Stuart Powell 1999, pers. comm.) recommends that in teaching people with autism pointers have to be given explicitly about what is important and useful (to remember) and what is not, in this way helping them to structure their memory in order to create autobiographical stories that they can tell.

In this section I discussed the importance of story-telling and autobiography in the social and cognitive development of children. Systems that support children's story-telling (e.g. as investigated in many projects part of the EU initiative Experimental School Environments (ESE), cf. (Machado et al., 1999), (Bobick et al., 1999), (Benford et al., 2000)) might play an important role in a story-oriented education for pre-school and older children. Such new *narrative technology* can potentially meet the social and cognitive needs of young primate story-tellers. This section also discussed how research in narrative intelligence could potentially be applied to autism therapy[3]. Narrative technology of this kind needs to make narrative skills explicit, make the implicit visible, highlight the underlying structure, point out (and possibly explain) what is important to remember and what is not.

A new generation of humanoid robots might even be used in autism therapy in order to test and teach social skills. Humphrey (1976:1988) argues for the necessity of developing a laboratory test of 'social skill' for primates. His suggestion is: "The essential feature of such a test would be that it places the subject in a transactional situation where he can achieve a desired goal only by adapting his strategy to conditions which are continually changing as a consequence partly, but not wholly of his own behavior. The 'social partner' in the test need not be animate (though my guess is that the subject would regard it in an 'animistic' way); possibly it could be a kind of 'social robot', a mechanical device which is programmed on-line from a computer to behave in a pseudo-social way." Thus, for Humphrey a test of social intelligence does not measure social 'reasoning', but addresses a social interaction situation. Nowadays we do have humanoid social robots (e.g. Breazeal et al, 1999; 2000) which, if they are accepted by human and non-human primates, could take the role of the interaction partner in such a social intelligence test. Generally, interactions between animate and inanimate social agents can indicate what kind of social knowledge is necessary in order to achieve a certain social behavior, e.g. how much 'theory' a social (and autobiographic) agent requires in order to be able to read others' minds. Systematic experimental tests e.g. with a social robot might also shed light on the role of narrative in social intelligence as discussed in this chapter.

Requirements for Narrative Agents

The evolution and development of natural social intelligence and story-telling is based on the primate social field. This chapter explained that 1) research in primatology points to the importance of social intelligence for the evolution of primate intelligence, and 2) autism shows how fundamentally an impairment of social skills, and possibly narrative skills, can influence the life of people, even if they show good non-social skills of intelligence. Thus, it seems that in order to make artificial (robotic or software) agents story-tellers, they need to be primarily *socially intelligent agents*[4] (Dautenhahn, 1998). Based on our previous analysis of the primate social field the following list of necessary requirements for a story-telling agent is suggested (this is not supposed to be an exhaustive list):

1. Individualized societies: The capacity to identify and recognize individual group members.

2. Social Networks: the capacity to establish, maintain, remember and utilize social networks. Ability to *predict* the behavior of others and outcomes of interaction. Agents need enough 'experience' and background knowledge in order to predict the future, and make the link to the past and present. Three basic elements in the primate social field are the following:

2.1 Ability to remember and learn interactions with others and to build *direct relationships*: As discussed above the upper limit of the group size was estimated for humans as 150, representing a cognitive limit on the number of individuals with whom one person can maintain stable relationships, as a function of brain size. The 'brain' of a software or robotic agent (at least in terms of storage capacity) can be huge. Thus, agents can have many friends.

2.2 Identifying third-party relationships (relationships among other group members), ability to remember and learn interaction between others. Since human communication is dominated by gossiping about other people, artificial agents talking about other agents seems to be suggested.

2.3 Ability to *understand* others, most elaborated in humans which show complex mechanisms of empathy, biographical reconstruction, and an individual autobiography. Agents need social skills, ways to figure out what other agents are doing and the ability to communicate with them.

2.4 Recognition of conspecifics as members in a group hierarchy/social structure (e.g. structures of kinship, allies, dominance hierarchies, etc.)

3. Efficient mechanisms of social bonding, either via physical grooming (in on-human primate societies) or via language and communication in narratives as efficient ways of *social bonding*, important for maintaining the coherence of social groups at different levels of social organization.

4. Social learning: the capacity to use others as *social tools* (Dautenhahn, 1995), via social learning mechanisms with varying degrees of what the animals learn from each other (cf. social facilitation versus imitation)

We hope that in future work these requirements can be sufficiently addressed in the construction of socially intelligent *narrative agents*, e.g. socially intelligent robots, cf. (Dautenhahn & Nehaniv, 1998), (Dautenhahn, 1999), (Dautenhahn & Billard, 1999), (Dautenhahn & Coles, 2000).

Conclusion

Narrative agents as we know them, e.g. humans and other primates, are social agents, grow up in a society, learning about other agents and how to predict their behavior. Also, narrative might be at the centre of who (we think) we are.

> "Our fundamental tactic of self-protection, self-control, and self-definition is not building dams or spinning webs, but telling stories - and more particularly concocting and controlling the story we tell others - and ourselves - about who we are.
>
> These strings or streams of narrative issue forth as if from a single source - not just in the obvious physical sense of flowing from just one mouth, or one pencil or pen, but in a more subtle sense: their effect on any audience or readers is to encourage them to (try to) posit a unified agent whose words they are, about whom they are: in short, to posit what I call a *center of narrative gravity*." (Dennett, 1989/91)

In this chapter I discussed the issue of narrative and story-telling from the perspective of primate social behavior and primate evolution, hoping that knowledge of who we are (as a species and as an individual primate) helps us understand the broader context and significance of narrative in human life. A more detailed discussion and analysis of the transactional format of narratives in human and other animals is given in (Dautenhahn, 2001).

Currently, a number of research project are devoted to building narrative software, virtual or physical environments e.g. (Glos & Cassell, 1997), (Machado & Paiva, 1999), (Umaschi-Bers & Cassell, 1999), (Bobick et al., 1999), (Montemayor et al., 2000), (Benford et al., 2000). Supporting, and possibly expanding, human narrative intelligence is expected to impact human minds and our notions of sociality and what we call our *selves*. In parallel, investigations into autonomous story-telling agents might result in agents (robotic or software) with genuine narrative minds, able to tell us interesting stories, listen to and understand our stories, and make us laugh. As I argued in this chapter, the kind of stories these agents will tell us will be shaped by the social field and the cultural environment of human societies in which these agents *grow up*. Thus, it is up to us whether the stories of the future will be nightmares, fairy-tales, comedies or adventures.

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Notes

1. This chapter is partially based on (Dautenhahn, 1999c).
2. See (Gigerenzer, 1997:265) for an analysis of the SIH as a "collection of loosely related assertions about the special role of the social (i.e. intraspecific) in the intellectual life of humans and other primates".
3. See other work (not necessarily involved narrative) that uses computer and robot technology in autism therapy, e.g. (Weir & Emanuel, 1979), (Strickland, 1996), (Blocher, 1999), (Dautenhahn, 1999), (Werry & Dautenhahn, 1999), (Dautenhahn & Werry, 2000), (Dautenhahn, 2000a), (Charitos et al., 2000), (Parsons et al., 2000), (Michaud et al., 2000), Autism & Computing (http://www.shifth.mistral.co.uk/autism/NAS/).
4. Selected Literature on Socially Intelligent Agents: (Dautenhahn & Numaoka, 1998; Dautenhahn, 2000b; Edmonds & Dautenhahn, 1999; Dautenhahn, 2000c; Dautenhahn, 2000d).