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How language evolved as a backchannel between two feedback loops

Abstract. Language is what makes us human. It is the basis of human knowledge, culture, and society. Despite its importance, how language evolved is still a mystery. Various recent studies suggest that humans developed through a "super-fast" evolutionary process found nowhere else within the animal kingdom. This suggests a discontinuity in the evolutionary process itself. We propose the following model: Humans evolved in a unique evolutionary system consisting of two feedback loops, there being a backchannel between them; the lower loop producing the variations needed for selection in the upper loop to take place. What is meant by the "backchannel" here is a structure enabling the selection of the lower loop to "anticipate" the selection of the upper one. The content of this backchannel is displaced action encoded in narration. We show that not only the human brain and language but also most of the unique human faculties (including theory of mind, episodic memory and the unique human altruism) are adapted almost exclusively to developing the functioning of the backchannel (narration) at a super-fast evolutionary pace.

Keywords: biolinguistics; evolutionary tipping point; extended founder effect; human altruism; human evolution; language evolution; Pullo-Vorenus-Hypothesis.

1. Introduction

Language is what makes us human forming the basis of human knowledge, culture, and society. Despite its importance, however, the evolution of language remains largely a mystery, and has been described as being "the hardest problem in science today" (Christiansen and Kirby 2003). Groundbreaking studies in neuroscience, primatology, anthropology, and cognitive science – based to a large part on new technology (including electronic data processing, DNA - analysis, neuroimaging technology) – have revealed data that were never accessible before. These have yet, however, to be brought together and synthesized into a larger picture. Perhaps the time is ripe now to develop from existing evidence an entirely new hypothesis, regarding how language evolved.

The starting point for our hypothesis outlined in this paper is the idea that *systems construct their own elements*. We will claim that there is something special about human evolution (cf. Lahn *et al*. 2004) and that a fundamental *system change* occurred *before* humans evolved. What is proposed is a discontinuity at the system level that came *before* the origin of our species and we think of humans and language being not the cause but rather the result of it. Our model thus fuses the question of the evolution of language with that of the *origin of our species.* In terms of the hypothesis presented here – both of these are the effects of a system change – one that can be referred to as a *major transition in evolution* (Maynard Smith and Szathmáry 1995).

The system that evolved basically consists of two feedback loops and a backchannel between them. The lower circle produces the variations needed for selection in the upper loop to take place. By "backchannel" we mean a structure whereby the selection of the lower circle "anticipates" the selection of the upper circle by implementing a medium that converts the differences of the upper selection into differences in the selection of the lower circle. The backchannel develops into an efficient medium in which language plays an essential role. We assume that most unique human faculties evolved *for* – and *in favour of* – this backchannel and were selected through competition for effective transmission. This needs to be clarified.

2. Background

2.1. Super-Fast Evolution: A sign that there is something special about human evolution

The development of the walking foot, the changes in the anatomy of the hands, the S-curved spine, the development of the human brain, the speech apparatus and cognitive abilities, and the like require so many fundamental changes that within the current established framework it seems close to miraculous that all these developments have occurred in such a short evolutionary period of time. Also, there is genetic evidence revealing gaps in our current understanding: our ancestors in fact having undergone fundamental genetic changes within the last 6 million years (Britten 2010; Hughes *et al.* 2010; Lahn *et al.* 2004). The changes found are very specific, indicating there to have been a strong and sustained selective pressure and the development of fundamentally new traits. Genomic regions have also been identified that are conserved in vertebrates in general but in the human lineage have accumulated substitutions at a markedly accelerated rate (Bird *et al.* 2007). The increased rate of substitutions found for the human lineage suggests that their function may have changed entirely (Burbano *et al.* 2012; Bush and Lahn 2008; Pollard *et al.* 2006; Prabhakar *et al.* 2006). It thus becomes clear that the notion that there is only little genetic difference between humans and chimpanzees (Diamond 1991) is nothing more than a popular myth. The large phenotypic divergence between humans and chimpanzees has been driven mainly by changes in gene regulation rather than by altered protein-coding gene sequences (single base substitution), by duplication (gene amplification), deletion, exchange between intron and exon, changes concerning the "frames" (Sibley and Ahlquist 1987). Genetic changes of all of these types are exponentially more powerful than single-base mutations are. Such fundamental genetic changes can only be positively selected if there are possibilities for evolutionary change suggesting the development of fundamental new traits. As Bruce Lahn has declared: "To accomplish so much in so little evolutionary time – a few millions of years – requires a selective process that is perhaps categorically different from the typical processes of acquiring new biological traits." Since Lahn found the pace of evolution here to have been about 16 times as fast as the development found in New World monkeys, he concluded, "Our study offers the first genetic evidence that humans occupy a unique position in the tree of life" (Lahn *et al.* 2004). This could be an indication for a *discontinuity in the evolutionary process itself*. To understand how discontinuities occur we introduce two concepts: the concept of *major transitions in evolution* (Maynard Smith and Szathmáry 1995) and the concept of the *evolutionary tipping point*.

2.2 Major transitions in evolution

A discontinuity in the evolutionary process is required for the shift from one working evolutionary system to another. These *major transitions in evolution* (Maynard Smith and Szathmáry 1995) are highly improbable events of strong impact that change how the evolutionary process works; their often involving such matters as the unit of selection, how information is transmitted, how variations emerge (heritability), and the frame of selection (the selection circumstances and the selector). Examples of such transformations are the emergence of the cell nucleus and the development of sexual reproduction. The large-scale acceleration of an evolutionary process is often an indication of a discontinuity of this sort. In taking account of this, one can hypothesize that the super-fast evolution of *hominini* – starting with the complete redesign of the locomotion system – could be an effect of a previously overlooked *major transition in evolution*.

2.3 The Evolutionary Tipping Point

The *evolutionary tipping point* (ETP) is the point at which a function becomes positively selected for the first time. Once this point has been reached, it may be relatively easy to explain how a certain trait developed further. Since the ETP is the point at which a function is positively selected for the first time, it is evident that a trait which was selected at the *tipping point* was not shaped by the selection for that particular function before. The ETP has in general the following prerequisites: a) the existing organism (constructed by evolution); b) the environment in question, and c) often though not always, a certain temporary context. At the *tipping point* a completely new function appears, one that generates reproductive advantages for the organism. The first positive selection of a new function that appears at the ETP is not necessarily based on a mutation alone, but can be based on the whole context in which the new function is positively selected. An ETP is triggered, therefore, by a fortuitous mixture of a genetic foundation, of behaviour, of circumstances, and of chance. This is especially crucial for the problem of the evolution of language, because language use is always situated in a specific social context.

3. Language – its structure and its unique function

3.1. Linguistic genius and footprints of evolution

It is widely agreed that language is unique to humans (making “human language” a pleonasm) and that it has a genetic component. To illustrate this point, Chomsky often gives an example of his granddaughter and her pet. Although both grew up in an English-speaking environment, only one of them learned to speak English. This point is also echoed by one of Chomsky’s most ardent opponents, Tomasello (2003): “Everyone agrees that human beings can acquire a natural language only because they are biologically prepared to do so.” The process of language acquisition (at the level of grammar) is quite distinct from learning by imitation, its instead being “rather like theory construction” (Chomsky 2010): the infant identifies certain sounds as language and then uses these data as evidence for a syntactic structure that allows it to generate an infinite variety of expressions. As a result, humans (including young children) can utter sentences they never heard before.

If a trait is complex and has specific features related to some particular function connected to its complex design, it is likely that the trait was the target of a selective process (Pinker 2010). Many features of language ability are so specialized that it seems highly implausible that they evolved for reasons other than for furthering linguistic abilities. This is especially true for powerful innate language-learning mechanisms, such as the ability of neonates to identify patterns of tokens (finding word boundaries) on the basis of statistical probability of the phonetic structure in fluent ongoing speech (Pelucchi *et al.* 2009). Neonates prefer language to all other acoustic stimuli (Shultz and Vouloumanos 2010) and are fascinated by language more than by anything else (Mehler *et al.* 2006); even foetuses recognize speech with sufficient clarity for this to influence the melody of their first cry (Mampe *et al.* 2009). Children are born with the presumption that language is structured in words that relate to each other to build propositions (sentences).

Most of these abilities seem to be so closely related to language that it would be difficult to imagine that they could have developed for non-linguistic reasons. In addition, it has been possible with the help of certain innovative techniques to detect those “footprints of selection” in the human genome that appear to most likely be connected with language (Przeworski *et al.* 2000; Bustamante 2010; Enard *et al.* 2002). In contrast to apes, which – if they are laboriously trained – use language for instrumental purposes (such as fulfilling their needs) humans “just love to talk” (Corballis 2011: 163). This is especially true of the innate language faculty suggesting a strong and lasting selective pressure on linguistic abilities.

3.2. Language did not evolve from animal communication

The common preconception that animal communication is the precursor of language is one of the major obstacles to understanding the evolution of language. Language and animal communication are separate and distinct phenomena that evolved separately and for different evolutionary functions (von Heiseler 2014). The parts of the brain in which the two are coded also differ. Instead, there is evidence that the *mirror neuron system* found in primates is the precursor of certain parts of the language faculty (Arbib 2005). This makes it likely that action reasoning is an important prerequisite to language. But what is the new exclusive function language evolved for, a function that animal communication systems do not fulfil, and why was it put under such strong evolutionary pressure?

3.3. The unique structure of language and its exclusive function

A trait always only evolves so far that it can fulfil its most challenging function, and in turn to construct a convincing evolutionary story of a trait we need to ask why and how it's most complex feature evolved. The most complex feature of language is syntax. In its simplest form a verb produces – depending on its *valency* – slots for different *thematic roles* (agent, patient, instrument etc.). The verb displays the relationship between the diverse *thematic roles* (marked by inflection, by word order, by a pre- or a postposition; in sign language: by role-taking, by line of sight, direction of signing the verb, by a generalized preposition etc.). Without the verb there would be no syntax. Yet what does the verb refer to? It generally represents an *action*. Syntax, and consequently language, is thus adapted to describe action. In turn there is no way to describe a displaced action or an absent event without use of syntax: a single utterance will always be interpreted as information about the present: if someone cries out "Fire!" she does not mean that the Bibliotheca of Alexandria burned down more than two thousand years ago, but that there is a fire here and now. Thus, the displacement of an action is possible only if an utterance is given a context through other words within a sentence.

From a cognitive point of view, propositions seem to be more fundamental than words. We do not simply put words together to build a sentence, but first we think of an event that we express in words. Words can thus be seen as *fission products* of propositions. The sentence "An ape grips the grape", for example, symbolizes a holistic sensorial experience, the perception of an action. The distinctions used are not "in the world" but are the result of *categorization* that implies a distinction between apes and non-apes, gripping and actions of all other possible sorts and between grapes and all other types of objects. Thus we could say: the perception of an action is *decomposed* by means of syntactic structure. Yet why should an individual decompose reality? We can think of at least two reasons: (a) for the *purpose of reasoning* (to understand "what is going on"), and/or (b) to tell someone about something that happened earlier and out of sight – to *narrate* displaced actions or events. The marvel of language is that it can describe an infinite number of events through use of a limited number of discrete elements (lexemes).

Goodall argues for the most important unique function of language being that of the displacement of action, that is, the communication of events that are not present, pointing out at the same time that "Chimps […] are unable to communicate about things that aren't present" (2010). Corballis (2011: 113–114), in turn, writes that "grammatical language evolved primarily to enable us to share episodes. […] Language is exquisitely designed to communicate who did what to whom, where, when and why." This suggests that language is adapted to describe action. We can further infer that the exclusive function is the communication of an absent action, because the existence of a present action could be communicated simply by pointing. "Absent" would mean something that happened in the past and out of sight: *storytelling*. Consequently there are good reasons to believe that language evolved for narration (for more evidence also see: von Heiseler 2014).

There is evidence that primates use a social reasoning system to understand the actions of others (Rizzolatti and Craighero 2004) and that they use this knowledge for social strategies, to build alliances, to manipulate conspecifics, and so on (Humphrey 1976; de Waal 1982; Byrne and Whiten 1988; Dunbar 2003). Yet why should an individual tell anyone about anything? Understanding *why* it could be a benefit to refer to something that happened earlier and out of sight could be the key to understanding the origin of language. Why did storytelling play such a prominent role in our evolution? All that would be needed is that a narrative sentence is uttered and would give the sender a reproductive advantage. The key to language evolution is therefore to find a scenario in which a narrative sentence would be strongly positively selected. This would mean that the first utterance (no matter how primitive) that referred to a past action conferring an evolutionary advantage on the sender would probably start an escalating evolutionary process, as a result of which the narrative ability would evolve even further. Since the understanding of action implies imitation and internalization (suppression of the physical imitation reflex) (Rizzolatti *et al.* 1996), the main challenge of signing a verb is therefore not the signing itself, but remembering a past action at the particular moment of language use. The challenge for the receiver would be to understand a simulation within the framework of a narration (understanding that signs refer to past actions). At the same time, the first narrative utterance that occurs should be a *tipping point* in evolution and would need to be connected somehow to a *major* *transition in evolution*, a point at which the agent (selector) or the object (the unit selected), and/or the transmission of information, changes. Yet why was such an immense selective pressure placed on the narrative abilities? What could be a context in which symbolizing an absent action would confer a reproductive advantage?

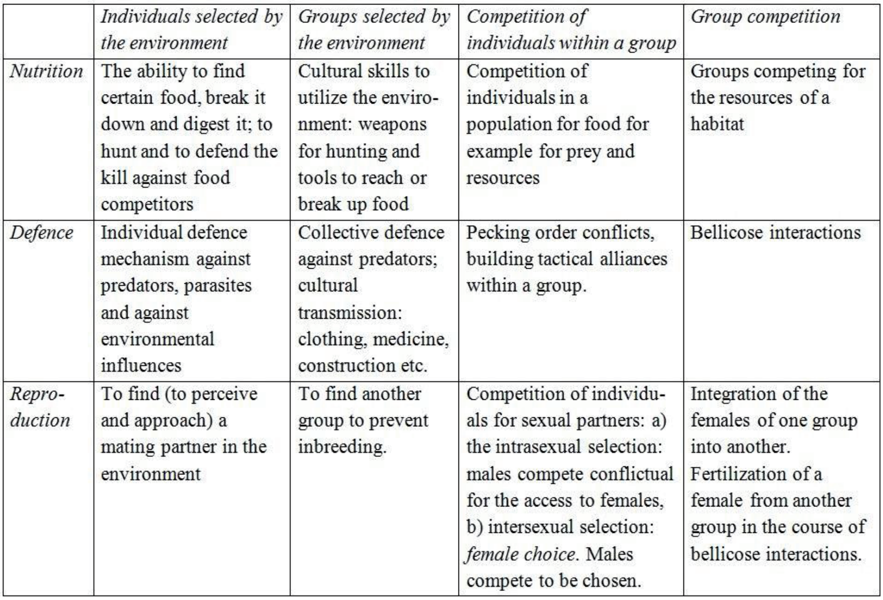
4. The model

4.1. Agents and objects of selection

We can classify different forms of evolutionary process according to the agent of selection (selector): natural selection (here defined as a selection by the environment!) and selection by conspecifics. Furthermore, the *object* of selection (Mayr 1997) can be either the individual (or, from a more abstract perspective, the allele of a gene pool), or – and let's propose (as a working hypothesis) if the gene pool of each group is closed and group hostility exists – groups. We can now cross cut these four categories with the three basic functions: nutrition, defence, and reproduction, and therefore construct twelve different categories of selection and thus concepts of the evolutionary processes (Table 1).

Without our consideration of a positive feedback loop and from an intuitive, evolutionarily naïve perspective, some aspects described in the second column (groups selected by the environment) – such as cultural skills to utilize the environment: weapons for hunting – appear promising, because the success of humans is closely related to cultural transmission and social achievements including cooperation within groups. This is why it is not surprising that many researchers use unwittingly concepts of this category, while on the other hand they officially deny – for good reason – naïve group selection. This does not suggest that what is denoted by the table's second column does not exist (that the cultural development of *hominini* groups and the collaboration of individuals do provide an advantage to the group), but that it can only explain why humans maintain their predominance over other vertebrates (showed e.g. by the fact that humans build and visit zoos, while other animals are kept in them), but not how their cognitive abilities and their unique altruism evolved in the first place. To suggest anything as the cause of an evolutionary process without explaining how the gene pool of a population changes its allele frequency is a teleological illusion, that is, *it confuses cause and effect.*

Table 1. *The 12 selection scenarios***:** *this table categorizes the concepts of selection that could be used to explain the human evolution: the first two columns refer to natural selection (in our definition: the selector is nature or the environment) and the last two columns recursive selection (selection of hominini by hominini). In the first and the third columns the individual (or its genes) is the object of selection, while in the second and fourth columns the group is the object of selection. All existing theories of language evolution can be categorized using this table.*



	Individuals selected by the environment	*Groups selected by the environment*	*Competition of individuals within a group*	*Group competition*
Nutrition	The ability to find certain food, break it down and digest it; to hunt and to defend the kill against food competitors	Cultural skills to utilize the environment: weapons for hunting and tools to reach or break up food	Competition of individuals in a population for food for example for prey and resources	Groups competing for the resources of a habitat
Defence	Individual defence mechanism against predators, parasites and against environmental influences	Collective defence against predators; cultural transmission: clothing, medicine, construction etc.	Pecking order conflicts, building tactical alliances within a group.	Bellicose interactions
Reproduction	To find (to perceive and approach) a mating partner in the environment	To find another group to prevent inbreeding.	Competition of individuals for sexual partners: a) the intrasexual selection: males compete conflictual for the access to females, b) intersexual selection: *female choice*. Males compete to be chosen.	Integration of the females of one group into another. Fertilization of a female from another group in the course of bellicose interactions.

Most monkeys and apes live in groups. They developed most of their cognitive abilities for social reasons to compete within groups (originally introduced by Humphrey (1976)), thereby triggering a cognitive arms race (de Waal 1982). An action reasoning system and a prototype of episodic memory – both necessary for the capacity for narration – are good candidates for being just the types of abilities that could have developed within the framework of this so-called *Machiavellian Intelligence* (Byrne and Whiten 1988). As we can see in our table: this already is a recursive adaptation process, because the selector is not the natural environment, but the other individuals of the group. However, the difference in the speed of this development between apes and *hominini* suggests that the competition for social intelligence cannot be the exclusive *cause* of the development.

Faced with the fact of super-fast evolution and the development of "capabilities that have no parallels in the animal kingdom" (Saxe

2013), it seems plausible to assume that an entirely new function emerged. The pace of the evolutionary development especially suggests a more powerful positive feedback loop.[1] Our table shows: there are more recursive adaptations possible beside the rank competitions within groups. The two most promising recursive selective scenarios seem to be: group conflicts (groups selected by groups) and sexual selection (an individual selected by another individual). Are they detectable in human evolution?

4.2. Recursive Adaptations

(1) War before Civilisation. There is evidence for war before civilization: most tribe societies engage in warfare, also our closest relatives, the chimpanzees, wage wars (Goodall 1986). The assumption that our ancestors engaged in conflicts is also well supported by a broad literature (among others: Darwin 1871; Keith 1948; Dart 1953; Bigelow 1969; Wilson 1975; Hamilton 1975; Van der Dennen 1995; Keeley 1996 and Pinker 2011). The most convincing evidence, however, shows that the recombination of male and female lines (the haplogroups of the Y-chromosome and the haplogroups of mtDNA) can be explained only by bellicose interactions and by the integration of females of the inferior group into the superior group (see 4.4).

(2) Sexual selection. The basis of (inter)sexual selection[2] is that males and females tend to differ in their level of parental investment. The sex with higher parental investment will be choosier, while the sex with lower investment is courting and advertising itself (Trivers 1972). Since usually the parental investment of the female is higher – beginning with the larger gamete and the gestation of the offspring – females often choose their mating partners more carefully than males do (Bateman 1948). Fisher (1930) showed that sexual selection can start by chance and then escalate.[3] In this context

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[1] A positive feedback loop could be a recursive adaptation process. This would occur if the agent and the object of selection – the selector and the selected – were the same: if the selective environment of a species were themselves. Under these circumstances, super-fast evolution seems possible. Because they produce their own selective pressure, with every development whatsoever the challenges grow, and the selective pressure tends to stay on the same level – depending on the asymmetry of reproduction of the individual within a group.

[2] There are two kinds of sexual selection: *intrasexual* and *intersexual*. In *intrasexual selection* individuals of the same sex compete conflictual for access to members of the opposite sex. In *intersexual selection*, one individual is chosen by a sexual partner. We will use the term "sexual selection" only to refer to *inter*sexual selection.

[3] If in a given population a female preference for a certain quality of a male emerges through mutation, then the male with this attribute will gain a reproductive advantage with that female, while not reducing his attractiveness to other females. This male's average mat-

traits can evolve that could not be selected "by nature" (by the natural environment). A strong dimorphism (differences between the male and female phenotype) is not a general sign of female choice – as is sometimes misunderstood,[4] but only of a particular type of sexual selection sometimes referred to as *handicap principle* (Zahavi 1975). The *handicap* works as a costly and therefore true sign of fitness: the male shows with a costly signal (e.g. with a big train that male blue peafowl develop), that he is fit enough to survive *despite* the handicap. The key to the success of this mating system is that males will inherit the *handicap* along with the fitness to survive with it, thereby ensuring them good mating chances, while the females will generally not inherit the *handicap* but will receive only the genes proven to be fit (by the handicap) from their (handicapped) fathers. Since the handicap will grow only to the point with the optimal cost-benefit-ratio it will find its equilibrium depending on the costs of the handicap, the nature of the female preference and the asymmetry of the male reproductive success. The costs are paid to the environment and the benefits depend on the female choice. The selective pressure through female choice is much more effective and will lead to a faster evolutionary process than any selection by the natural environment and even for social intelligence. The crucial point concerning human evolution is that theoretically anything can be the target of sexual selection. The only prerequisite is the perceptibility of the trait for the choosing female.

Neither group conflicts nor sexual selection alone can explain human evolution. Sexual selection is indeed a very powerful mechanism, but as Fisher (1930) explained: anything could happen, and its outcome is entirely unpredictable (Miller 2000). In contrast the selection between groups could guide the development in a certain direction (towards bellicose competence),

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ings with all females plus his exclusive matings with the females who found his appearance desirable will sometimes lead to the favoured quality spreading through the population, because the offspring of the male with the favoured quality will not only inherit the trait from its father but also the female preference for it from its mother. Thus the genetic basis for the female preference is spread piggyback with the desired quality in the evolutionary process.

[4] For example: Deacon (2010) writes: "sexual selection inevitably produces complementary divergence of male and female traits" and takes this as a reason to doubt the relevance of *female choice* for the development of the most distinctive of human traits as language and other cognitive abilities: "Therefore, accounting for the extravagant complexity of language in terms of sexual selection requires explaining why it lacks this otherwise-ubiquitous mark of extreme sexual dimorphism." Deacon confuses *sexual selection in general* with a special type of sexual selection, namely the *handicap principle.* Only the latter will produce a strong dimorphism. This dimorphism develops in two steps: first the trait (handicap) evolved due to the sexual selection and then this trait gets suppressed in females by natural selection on the level of gene regulation.

but would not be very powerful, because here an evolutionary mechanism is missing on the gene level. Furthermore there would be no motive to engage in the bellicose interactions if they were risky. Likewise the unique cognitive ability, especially language, could not be selected by group conflicts. But what would happen if both mechanisms would intertwine?

4.3. The ideal(ized) scenario

If the two recursive processes – intersexual selection and the selection between groups – interlock, then a dynamic system emerges in which sexual selection creates random variations on a group level in a runaway process, and these variations then get selected through bellicose interaction. Both sexual selection and bellicose interactions can select traits that the environment cannot. To kick off, this doubly recursive process requires the closing of the gene pool (no casual intermingling between groups). The transformation of the gene pool proceeds now at the speed of sexual selection, a speed more similar to that of artificial selection than of natural selection. But since the groups (only if their gene pools are closed) as a whole are objects of selection, cultural elements and group structures can also be selected by and for bellicose interaction. Both the speed of the development and the kind of traits that can be developed change fundamentally. All this allows us to categorize the emergence of this unique evolutionary scenario as a *major transition in evolution* (Maynard Smith and Szathmáry 1995), alongside, for example, the emergence of sexual reproduction or even the genesis of eukaryotes.

4.3.1. The Extended Founder Effect

The evolutionary process depends on the production of variations between the selected entities. If groups are the target of selection, then the speed of the process depends on the ability of the system to produce differences on the group level. The speed of development depends on two factors: the sexual selection as a runaway process and the separation of new founder groups from a source group. The latter is based on what we call the *extended founder effect* (introduced in this paper). The *extended founder effect* is the hypothesis that in the *hominini* line the splitting-off of new founder groups from a source group includes – beside what is known as the *founder effect*[5] – also non-

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[5] The *founder effect* occurs when a small number of migrants split off from a larger population. The new founder group always has less variation than the source group – because

random elements: related individuals of the same sex could join the same group, based on social bonding or kinship in the source group, *assortative mating* – the choice of mating partners with similar phenotypes (MacDougall and Montgomerie 2003) – could also play a crucial role. The strongest impact, however, would occur when the formation of new founder groups of *hominini* is influenced by sexual attraction. In other words, the female preference and male traits must fit. If a subgroup of males with strong social bonds were to separate from a bigger group, then the females who were attracted to them would follow them – or vice versa. And since the reproductive success of any trait depends on the *female choice* for that trait, the most important factor of group formation is the nature of female preference. In other words: the extended founder effect will isolate different female preferences with the effect that every isolated group is dominated by a slightly different female choice. Most of the features facilitating the formation of *non-random* founder groups will increase in line with growing cognitive abilities. This is to say: the expanded founder effect increases during the evolutionary process. Up to now we observed our scenario on the system level the groups being the variations and the object of selection. But how could such a scenario be possible on the level of the individual and evolutionary stable?

4.3.2. Bravery as a Handicap

If different female preferences prevail in different groups, the object of selection in intergroup conflicts is – indirectly – the predominant female choice. This is a two-step-process: first a preference develops by chance changing the allele frequency of the gene pool of a group and then the groups compete for territories. The selection on the group level is a selection between blind and contingent variants. In this process those female choices will survive that will produce groups that replace others. For this system (variations produced by sexual selection and the *extended founder effect* that get selected by group conflicts) to function effectively, the groups must regularly engage in group conflicts. Since participation in such conflicts requires the risk of self-sacrifice for the good of the group, this leads us to the problem of altruistic behaviour. If there were an imaginary *group of the brave*, the individuals of the group would not use an *evolutionarily stable strategy* (ESS), because

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it carries only a cut out (a random section) of the original gene pool of the source group (James 1970) – and can, by chance, be distinctively different from the parent population from which it derived. In smaller groups, genetic drift can also play a significant role (Mayr 1942).

an individual member of it who was a *coward* would manage to benefit from the replacement of other groups without risking his own life.

The super-fast evolutionary process of *hominini* legitimates the construction of an *ideal scenario* that would make this extraordinary development possible. In a second step we will ask how this idealized scenario is possible. The ideal scenario would be that the differences in males' *victory related behaviour* in the bellicose interaction are translated into differences in reproduction. Here we face a classic mapping problem: we have differences on one side (difference in the war-like behaviour) and differences on the other (difference in reproduction influenced by female choice), and we need a medium for the transmission of these differences over time and space. This is to say: behavior in war-like interactions needs to be translated into mating frequency: the females would need to choose their mating partner according to their *perception of absent actions*. If this system works, bravery would be a "handicap" (an expensive and therefore true sign of fitness (Zahavi 1975)), and would play the similar role as the train of a peacock. As mentioned earlier, one requirement of a handicap is its perceptibility. In this case the "perception" of the male behavior in the war-like interactions is not observed directly by females but only through a channel that transmits differences of the male behaviour in the bellicose interactions to the female consciousness influencing their choice. Also the channel needs to overcome space and time. Space: the bellicose interactions will be in most cases not in a visible distance to the breeding area. Time: the bellicose interaction will not be followed by mating instantly. A good medium for the transmission of male behaviour in bellicose interaction would be narration. In other words, females would need to love war heroes as they appear in narrations.

On the system level this would equate with a backchannel. Before the back channel is implemented the sexual selection and the *extended founder effect* would produce variants on the group level that are blind for the selection in bellicose interactions. Now by the emergence of the back channel the selection of the lower level (female choice) can somehow orientate itself towards the selection of the higher level (the bellicose interactions). This makes an altruistic behavior in form of bravery evolutionary stable. In other words: a behavior that *appears* to be altruistic becomes the best strategy to spread the genes of the individual. The size of the handicap (the optimal degree of braveness) would depend on the variation in male reproductive success and the value placed on the handicap of bravery in the female choice. The groups therefore compete in the variation of male reproductive success and in the "clearness" of the backchannel.

Since one's reputation is about one's exploits of war, the social structure is indirectly (through the production of bravery as a handicap as transmitted by the medium of narration) oriented towards the outer challenges of the group. This is to say: because the female choice is the most important factor of the development of a group the changing of the gene frequency can orientate indirectly on the outer challenge.

In the ideal situation, the individual providing the greatest benefits for the superiority of the group would reproduce most often. This ideal scenario obviously never can be achieved because the contribution to a victory of an individual will not always be perceptible and the medium of narration always includes interference (noise). The perfect channel, however, would seamlessly connect *the behaviour relevant to ensuring victory* and *reproductive success*. In reality even the *orientation* to heroic deeds could be quite "noisy" (corrupt), because the victory-relevant behaviour is not always visible for anyone – and even if it is, certain crucial qualities can hardly be successfully transmitted by narration. However, the major noise source – decoupling successful war behaviour and reproduction – would lie in the narration itself: if males could make females believe that they are braver than they actually are, it would give them a considerable advantage, because they would not need to put themselves as much in danger in order to reproduce equally. Every male will try to find a way to "cheat" and thereby corrupt the system: not in a conscious way, but through the evolutionary logic of variation and selection on the individual level. If a male could propagate his genes without constantly risking his life, this strategy would spread through the population; therefore, self-propaganda would be one of the biggest interference sources in the backchannel (relating bravery in war and reproduction), as it could minimize the costs of bellicose bravery and increase the benefits from female choice, thereby decoupling reproduction from victory-critical behaviour. This form of corruption could escalate because females that would choose linguistic genius would probably give birth to great talkers, which will be disproportionately successful.

All this leads to a dialectical development: the language ability would be on one hand a show-off behaviour that would disconnect reproduction from bravery – and therefore be the main interference in the backchannel – while on the other hand, in the long run, the selection of the great talker would improve the *resolution capacity of the channel* (how precise a narration about the bellicose interactions can give a picture of what really happened). Paradoxically, the channel in this autopoietic system improves itself by its own noise.

The aggressiveness of a group does not reflect the variation in male reproductive success in general, but only the part of the female choice (which produces the variation of the male reproductive success) that is guided by the attraction level to bravery. Because the optimal quantity of bravery – as a real risk taken in the bellicose interactions – becomes minimized by the female choice for the great braggadocio, the level of aggressiveness of groups in which this female preference rules will decline, and the groups in which the females care more about the great talkers will avoid other more aggressive groups and may settle in less attractive habitats or even immigrate to uninhabited regions.

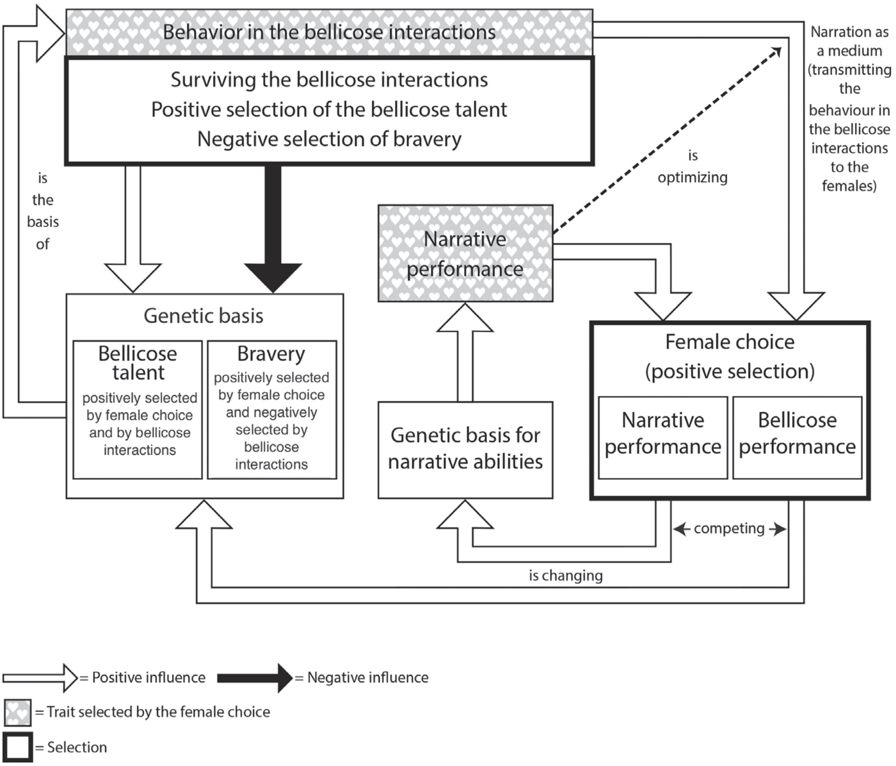

Figure 1. The feedback loop structure within a single group. There are two feedback loops both depending on the nature of aspects of the female choice: A = positive selection of the bellicose performance (outer loop); B = positively selection of narrative performance (inner loop). (A) The outer loop includes two selective mechanisms. (A1) The female choice selects the hero how he appears in the medium narration and thereby selects the *bellicose talent* and the *bravery* positively. (A2) In the bellicose interactions the *talent* is selected positively while the *bravery*

is selected negatively. This complex outer loop results in: (1) a *regulation* of the degree of *bravery* and (2) a *positive selection* of the *bellicose skills*. (B) In the inner loop the male *narrative performance* (based on the narrative competence) is selected by the female choice. This is a positive loop limited by the positive variations on the gene level. The outer loop (A) and inner loop interact in two ways: on one hand both loops compete, because the female choice for *heroic behavior* (as transmitted by narrations) and *narrative performance* compete; on the other hand the result of the escalation of the inner loop (narrative competence) is the basis of the media (narration) of the outer loop. Every improvement of narrative competence improves the media of narration and thereby the transformation of victory-relevant behavior in the bellicose interaction into reproduction. Because the inner loop selecting the narrative competence is positive, while the outer loop (positive selection of bellicose skills, regulation of bravery) includes a negative selection (bravery in the conflicts between groups), the system itself shifts towards the inner circle. As a result the females will be less and less impressed by *bellicose skills* and more and more aroused by *narrative performance*. However, in bellicose interactions the groups compete in the strength of the outer loop. For this four aspects play a part: (1) the asymmetry of the male reproductive success; (2) the quality of the backchannel primarily premised on the narrative skills; (3) the extent to which the female choice is influenced by heroic deeds as they appear in narrations in contrast to other preferences (including narrative performance) and (4) the danger of bellicose interactions depending on the bellicose skills, the culture of a group and relative strength of the competing groups. The strength of the outer loop conforms to the averaging (and evolutionary stable) level of bravery and therefore corresponds with the aggressiveness of the group. Time scale: the outer feedback loop is a regulator that can adapt to the optimal level of bravery and aggressiveness of the group in a few generations. The fastest chance concerns the danger of the bellicose interactions depending on the strength of other groups. An expanding superior group will therefore turn more and more aggressive. The calibration of the bravery level can also include personal experience and epigenetic effects. Another result of this system is the escalation of bellicose culture, including weapons, tactic of ambushes, war paint, techniques of signal transmission, methods of synchronisation, practises of motivation (such as war dance), formation of combat units etc. The bellicose skills adapt to the bellicose culture. Furthermore the narrative competence escalates in this system and thereby many heterogeneous sub-skills. This escalation is limited by the positive mutations concerning the narrative competence.

In isolation the system tends to the inner circle because a good narrator does not need to put his live in jeopardy. Because the great narrators will be more successful than the great heroes, the female choice for the great narrators will be more successful as well. This will reduce the optimal level of bravery. In contrast: in bellicose interactions the groups compete in the strength of the outer circle. Groups governed by female choices that prefer great talkers would be replaced by groups ruled by female choices that prefer the great war hero. This makes it likely that victorious groups by chance develop a culture that blocks a fast decrease of bravery through female preference for good and well performed narration.

4.4. Problem of the reduction of variability and the integration of females

If a dominant group were to displace all other groups and spread throughout all habitats, genetic variability would be extremely reduced: the variability of all populations of all habitats would be reduced to the original variability within the dominant group. Since evolution always depends on genetic variability, the victory of a small group over all others would limit the possibility of further development. Moreover, it is likely that in all groups some beneficial mutations could emerge; all of which would be destroyed by total replacement. In fact, there seems to be a mechanism that not only has a distinct advantage for overall development (selected in competition with developments in other regions) but which also pays off at the level of the individual (or its genes). This is to integrate healthy, young, attractive females from the losing group into the victorious group. The advantage on the genetic level is on the side of the males of the victorious group. For the overall process, however, it is important that all mutations that can be the object of later sexual selection be retained, even if they develop in a losing group. As the female preference may simultaneously be for different characteristics in different places, it would be possible for different qualities to develop in different groups, which then get recombined by bellicose interactions and the appropriation of females from the losing into the winning group. The only prerequisite for the survival of these new qualities introduced by the females of the losing group is for these attributes to be a target of positive selection by female choice (either this preference could be already found in the predominant group – say for narrative abilities – or it could be introduced by the integrated females). Because the narrative skills do not produce as many costs as the brave bellicose performance, the genes concerning the narrative abilities will spread through the dominant group.

This recombination is particularly important in terms of the development of complex traits. This is especially true for those concerning the formation of narrative ability, since this includes various skills on many different levels that can be selected by female choice (see 4.5). Every aspect that produces perceptual differences can be chosen by sexual selection, including linguistic complexity, and narrative clarity (intelligibility of the narration). In the next generation, the backchannel therefore could be improved and differences between groups concerning the clearness of the backchannel could get selected on the group level.

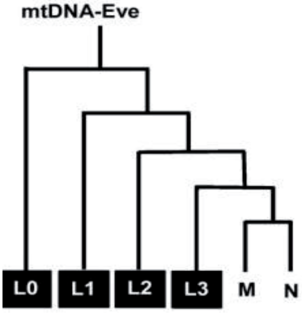

Figure 2. *Simplified tree of the female blood line. Black = African Lines*

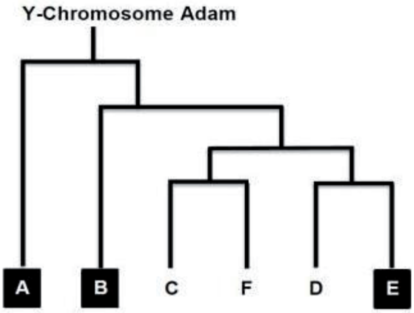

Figure 3. *Simplified tree of the male blood line. Black = African Lines*

There is evidence for the recombination of male and female lines that lie in our genes. The different structure of the Haplogroups of the Y-Chromosome and the Haplogroups of mtDNA can only be explained by bellicose interactions and by the integration of females of the inferior group into the superior group.

4.5. The Speed of Evolution and the development of the unique human traits

The speed of evolution depends on the production of variation, on the probability of the variation being an improvement, on the number of fields in which improvements are possible, on evolutionary pressure, and on the number of individuals involved in the evolutionary process. Bigger changes will be based on mutations of the gene expression and include insertions and deletions (Britten 2010). But those bigger changes can be positively selected only if there is something to improve. Most traits are already optimized in a long evolutionary history. Furthermore, the problem with most traits is that any change can be destructive. Narrative abilities, however, can improve on many levels simultaneously and if a certain quality is improved in the next generation, the demand will also improve, while the selective pressure will be constant, depending on the variation of the male reproductive success. There are different fields that could be positively selected if the narrative performance would confer a reproductive advantage for such heterogenic qualities as: vocal characteristics, humor, theory of mind, episodic memory and lexicon size could develop. In other words: narrative skills are comprising many widely different sub skills and all of them could be tested by narrative performances. It is likely that the female choice will be oriented around the qualities that produce significant perceptible differences (based on the female's own cognitive abilities). First females will only be interested in males that fulfil the minimum standard in all perceptible fields (size, symmetry, signals of health, beauty of the gait, status, smell, etc.), than they focus on their preferred field, but would also appreciate significant improvements (differences to other males) in all other fields. In the case of *hominini*, positive mutations can be combined through the back flow through the female germline into the surviving group.

Alongside *episodic memory*, having a *theory of mind* is an important prerequisite for being able to tell a complex story. First, a good storyteller always needs to keep two things in mind: the whole story (his own knowledge of the narration) and what he has related of it so far (the knowledge of the receiver of the story). Second, to understand a story, both the narrator and the receiver need to understand the motivations and beliefs of the hero (because to understand a story means to understand the motives of the hero). The receiver needs to assume that the hero acts according to his knowledge and not according to objective facts. However, the narrator has to make sure not only that he himself understands the motives of the hero, but also that the receiver understands them at every given point in the story. Thus, to understand whether the receiver grasps the story, the narrator needs a second-order theory of mind (i.e., he needs to understand what the receiver believes the hero believes). From this we can conclude that the *theory of mind*, the ability to understand the beliefs and motivations of others, will be put in the adaptation process to narration under a strong selective pressure.

4.6. Evolution and cultural development

In our scenario, language is neither simply adapted to the brain, nor the brain simply to language, instead, *both language and brain adapt to storytelling.* Some of the abilities will be useful mostly for language (e.g. specialized learning algorithms, phonology, syntax, lexicon) others can be used for other social and cultural aspects (e.g. episodic memory, *theory of mind*, prosody).

After the *evolutionary tipping point*, – the first narrative utterance that conferred a reproductive advantage – human brains and language are both selected for the beauty of narrations (beauty is here defined as the *attractiveness of a narration*: the qualities that make the narration pleasant and the narrator attractive). Every adaptation of the brain and its cognitive capacities changes the selective pressure on language (as a cultural entity), and every development of language and its use slightly alters the selective pressure on the cognitive capacities and the brain. The human brain structure can be explained on one hand by older features, which developed for other reasons (in the long evolutionary history of animals, vertebrates and apes) and on the other hand by the adaptation to narration, structures specifically developed in our scenario. Likewise, the structure of narration is based on cognitive capacities and in particular the language abilities, and the cultural transmission including lexicon, syntax, narrative conventions and so on. This is to say, the springboard of this recursive evolution is the pre-existing structures of both brain and language (as part of the culture in a certain group), but will be subdued under the selection for the beauty of narration.

5. Discussion

5.1. Selection on two levels and the closing of the gene pool

Sometimes it is said, that if there are two levels of selection the lower level (e.g. competition between individuals) would be stronger while the higher level (e.g. competition between groups) would be much weaker. But this is misleading because “strong” and “weak” would presuppose that both would work on the *same* level. A complex trait can never be the result of the group level and the selections are not comparable on a one-dimensional scale. For example: it is likely that the *Homo sapiens* displaced the Neanderthals in Europe about 35.000 years ago, because *Homo sapiens* developed a mimetic culture. But it would be impossible that the *Homo* *sapiens* developed mimetic culture *in order* to displace the Neanderthals. That *we* populated the planet and not Neanderthals could be therefore caused by a selection between species – what makes it a big difference (at least for us). Such an effect can hardly be called "weak". But "weak" would be also wrong in another sense: no complex trait can ever be formed by any selection of the group level – no matter how slow.

These two levels of selection are generally found on the level of the individuals (or its genes) and on the level of species that compete for the same niche. However, in this competition not only the individual fitness plays a role, but also the social structure, the mating system, the level of collaboration etc. The level of collaboration can never be a direct result of the selection between species, but if the replacement process would happen often, it is likely that the surviving species has a beneficial social structure. In the regular evolution the selection on the higher level (on the level of species) is very rare and could only happen in some millions of years. If the individual of a species – as suggested by our model – would not interbreed arbitrarily with other individuals of the same species within a habitat, but would build groups that would interbreed only exceptionally, the pace of the selection on the higher level would increase enormously: every split off of a new founder group would provide the selection on the higher level with a new variation.

This would implicate that the proof that *hominini* in a habitat are not interbreeding arbitrarily (but are building groups to do so), would be indispensable for our model to work. The evidence for this special social structure of our ancestors comes from different fields: (1) the comparison of the structure of the human male germline (Y-Chromosome line) and the female germline (mtDNA-line) shows that groups are not intermixing with other tribes arbitrarily and makes it seem likely that groups displace other groups by killing the males and integrating some of the females (see 4.4). (2) The different tribes on the Andaman Islands do not interbreed for thousands of years and keep their very diverse appearances. The same is true for the tribes in New Guinea (Diamond 1991).

5.2. How could the transition in evolution emerge–leading to the development of humans?

The starting point of our scenario would be the closing of the gene pool. There is evidence that this change into a new mating system was triggered by a climatic change. While in western and central Africa the tropical rainforest remained, volcanic activities led to the development of a natural barrier, as a result of which the region east of the Great Rift Valley dried out continuously (Coppens 2004). In an open and clear territory consisting of isolated gallery forests surrounded by open grass fields – such as developed increasingly due to climatic shifts – having intercourse with individuals from another population without being discovered appears practically impossible, especially because the territories in the savannah are much more expansive than in the rainforest (e.g. while a group of chimpanzees in the forest has a home range from 5 to 40 square kilometres, their territories in the savannahs are 120 to 560 square kilometres). If now in one population the males guard their territory, kill all males that enter it to mate with their females – and at the same time mate with females of other groups – this behaviour will spread through all groups through the male germline or by the replacement of the groups with other strategies. The system that emerges here has two positive feedback circles *but no backchannel* between them: the selection on the lower level is blind to the selection on the higher level. The lower level (sexual selection) can only indirectly – by trial and error – adapt to the selection of the higher level (group conflict). On this stage genes that help males *survive* in bellicose interactions will spread through every single surviving group. However, female preference cannot identify the good warrior directly.

On a more abstract level, we could say that the target of selection is the predominant female choice of a group (selected in bellicose interactions). A good female choice would be enhanced bipedalism to free the hands for weapons (e.g. rough stones to strike and to throw, clubs and spears from perishable material) and to pick the good hunter. If the female choice fortuitously favours the upright gait or position as part of the courtship behaviour (e.g. the male showing its genital), the upright gait would evolve with maximal speed. This process could be reinforced by the use of sticks in status competitions within groups. One group making critical progress would replace all others. With this replacement the female preference for the upright gait would spread, and therefore improvements concerning upright locomotion could happen in different groups simultaneously. The best way of choosing the good hunter would probably be to find males attractive that present hunting trophies. If now the females would orientate on the distinctive signals between males they would choose rare hunting trophies. This would make the animals to hunt bigger, harder to hunt and more dangerous. This is to say: because female choice is successful when it detects distinguishing (distinction creating) qualities the hunted animal grows bigger and more dangerous in the evolutionary process until the most dangerous animal would be the *hominini* himself. This all would be possible without any representation or any understanding that a war or hunting trophy signifies an absent action and could be explained just by the logic of the system itself. This already would be a back channel on the system level, even if it would not include any consciousness of an absent deed. The consciousness of the displaced action is therefore a result (and not the basis) of the back channel. The advantage of understanding a trophy as a sign lies in the improving of the detection of fitness and is more flexible than the instinctive preference for a rare trophy. Now, what would be the most effective technique to present a trophy? A good way would be, to present it in an engaging way, to make some noise to attract attention and maybe repeat a movement showing the killing. This "showing the killing" would be a mimetic gesture, a sign that would refer to a displaced action. This would make it a narrative proposition. If this narrative proposition were positively selected, this would be the *tipping point* for the evolution of language and the starting point for a *selection for narration*. The simplest possible narration (SPN) could be:

>I< >kill[ed]< >[this] enemy< >[with a] stone<

This miniature narration (SPN) is, we imagine, only one gesture (likely to be repeated) added to the presentation of the war trophy, but the crucial point is that *this gesture would signify a past action.* In this first signed proposition there is no chronology, because the signing only contains one movement. The agent would be an implication (the narrator himself); the verb would be a mimetic movement (*signifying a past deed*); the instrument the real weapon and the patient itself: the dead body (the signifier) stands for the living enemy or animal (the signified). If this simplest narration (SPN) is understood and creates a reproductive advantage, the narrative abilities would get into a positive feedback loop and escalate. Because the index, in the form of the trophy, needs to be always present, there is no danger of lying.

Since the understanding of action implies imitation and internalization – suppression of the physical imitation reflex (Rizzolatti *et al.* 1996) – the main challenge of signing a verb is not the signing itself, but remembering a past action at the particular moment of narration. Thus the major cognitive challenge would not be the imitation itself, but the reference to the past event. To become narration the action must be stored as a memory, which must then be accessed in a narrative situation. On this stage the remembering of the past event is always triggered by the presenting of the trophy. However, an even bigger cognitive challenge lies on the side of the receiver and requires the understanding that the mimetic gesture is representing a past action. With the first narrative utterance that had a reproductive advantage to the sender the existing abilities are put under a selective pressure *for narration*. After this ETP, the escalation of the system includes the development of all cognitive features that are necessary for a good narration. Another critical point in this development would be the point on which the narrations would circulate within a population. This can occur only if someone else retells someone's narration. For this to happen there must be a motive to tell a story about someone else. The motive is obvious in the case of first person narrations, since they valorise the narrator. But why should anyone tell a story of anyone else? The only reason to tell a story of someone else would be if this behaviour would generate a reproductive advantage. This could happen when females would be fascinated by good narration and the narrative skills itself. Therefore the question would be: Why is it a superior female choice (and therefore an *evolutionary stable strategy*) to choose the male with impressive narrative abilities? A narrative genius would gain a greater reproductive success with the same bellicose performance. This advantage would be massive because while bravery in the bellicose interactions could be costly, the narration is not (but limited by the narrative competence). When narrations are circulating, the burden of proving truth switches from the indication of the trophy to the controlling of a narration through other narrations. In other words, in the I-narration world, a narration can only be told if the narrator can present a trophy. This makes bellicose interactions a competition to acquire war trophies and also makes later conflicts about the possession of the war trophy probable. The change to a system with circulating narrations, in which every narration is controlled by other narrations, suggests a more cooperative strategy. When narrations are the exclusive backchannel, the female choice is attracted to great narrators and to the hero as he appears in the circulating narration (as females today are turned on by heroic deeds and entertaining narrative performances). Furthermore not only does the genetic basis of the language ability evolve, *but language itself adapts to its narrative function,* which in turn gives rise to new challenges for the narrator. The cultural aspects of language develop due to their adaptation to the narrative conventions of a special culture and thereby modify slightly the selective pressure (also depending on the female preference concerning narrations). Thus the challenges could vary between different groups and could therefore produce different adaptations that can later be combined through the female germline. If the female choice would be orientated on *distinctive* linguistic qualities, it could trigger an escalation of complexity even beyond communicative efficiency. From this we can assume a super-fast evolutionary pace of both the narrative ability and narrative conventions on different levels including syntax.

5.3. Methodological reflection

For heuristic reasons we first developed an ideal scenario. That does not mean we claim humans to have evolved in a perfect or God-given evolution, but that our scenario is simplified and idealized. The method is first to develop a scenario that would solve the given problems (such as the development of the unique human abilities in a super-fast evolution) and then to examine how it could possibly be implemented – presupposing it would work much messier in reality than in our concept. The background of this simplification is abstract cybernetic modelling (see Wiener 1948). This is to say that in the modelling of a self-regulating system (Foerster 1981) we would first search for possible feedbacks, analyse the logic of transmissions of signals dictated by the nature of the media, etc. (see von Heiseler 2008). The benefit of this perspective is that it can identify differences that would be unrecognizable in direct observation. Two examples: (1) at a certain state in the development of our ancestors our scenario predicts a male acquiring a reproductive success by presenting a trophy. This could be a gazelle, a fang of a hippopotamus or a hand of *hominini* from another group. For a direct observation there is no big difference between all three trophies. For a cybernetic modelling there would be a vast difference between a hunting trophy and a body part of a *hominini*, because the war trophies would create an endless positive feedback (as an arms race) and would implement a backchannel between female choice and intergroup conflicts. (2) If there would be a direct observer of our early ancestors she probably would find that a main influence on the reproductive success would be based on inner group competition, alliances, status etc. and that even the female choice would mainly be affected by the status of an individual. But once in a while the female choice is influenced by the presenting of war trophies and narrative abilities accompanying the presentation. Here again we detect a positive feedback and realize that this kind of female choice would be the foundation of an orientation of the social system of a group as a whole on an outer challenge (the intergroup competition): The lower feedback circle (the female choice) gets *informed* by the higher feedback circle (group competition). As with all positive feedback there will be an escalation. Thus the cybernetic modelling can predict the development in this case much better than direct observation.

5.4. The consequences

With our scenario we can explain the development of most unique human abilities, such as theory of mind, episodic memory and language: everything that could be selected by selecting a good narrative performance. Furthermore the circulating narrations could be the basis of the unique human altruism: if reputation is based on the circulating narrations, behaviour that could be observed by any possible narrator will be influenced by the anticipation of the narration about the behaviour. In other words: Acts will be shaped by possible narrations about them. Individuals transform into society members. Every act is controlled by the imagination of one's reputation. The consequence: a reputation-economy based on narration is the basis of the unique human social order.

For further research it could be productive to investigate the importance of narrations for our lives and the cultural development of narration. The essence of an object often relies on its origin (such as the difference between an original piece of art and forgery). This means it is constructed by a narration. Myths give people an identity, our self-concept is based on our autobiographic narration, fictive and religious narration can give us role models and our reputation is encoded in gossip and other forms of circulating narrations in different media. Everything that is essentially meaningful to us is connected to narrations.

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