

# Animal communication, animal minds, and animal language

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## **Abstract**

The communication systems of nonhuman animals are reviewed, together with a discussion of their relevance for the evolution of human language. The teaching of language to nonhumans, as well as signs of mind and consciousness outside our species, are considered as possible bridges between us and the rest of the animal kingdom.

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# 1 Introduction

Human beings are in many ways unusual animals, with some very peculiar adaptations. In most respects, however, the difference between us and other animals is a matter of degree only. Our species uses tools more than any other, but other species *do* use, and even make, tools<sup>1</sup>. We may be the *most* intelligent animal on this planet, but chimps and dolphins aren't totally devoid of intelligence either. We are the only species to run a global monetary economy, but trade and bartering are not unknown in the animal world (de Waal & Berger, 2000; Hyatt & Hopkins, 1998; de Waal, 1997). We have the most extensive body of social and cultural knowledge, but other species learn<sup>2</sup> from each other as well (Nagell et al, 1993), and pass on cultural patterns (Vogel, 1998; Whitehead, 1998; Boesch & Boesch, 1990; Vogel, 1999), leading to distinct cultures in different populations of chimps (de Waal, 1999; Whiten et al, 1999; Whiten & Boesch, 2001), orangutans (van Schaik & Knott, 2001) and whales (Rendell & Whitehead, 2001). And so on... The more we learn about chimpanzees, the more kinship we can observe — and feel! (Goodall, 1998)

There remains only one important area in which it can still be argued that we are unique, and that is our habitual use of language. No other species has anything remotely approaching our language capability, and many linguists maintain that no other species has any language at all.

Nevertheless, we have overwhelming evidence that we evolved from an ape-like ancestor in just a few million years, and so our language capabilities must have evolved as well, presumably through some sequence of intermediate stages. A detailed review of our

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<sup>1</sup>The *making* of tools is reported only for chimpanzees and bonobos (pygmy chimps) (Boesch & Boesch, 1990) (who even make stone tools (McNeil, 1996)), but numerous species have been found to *use* tools, including all the great apes (Sugiyama, 1994; Nakamichi, 1998; van Schaik & Knott, 2001) and some monkeys (van Schaik et al, 1999; Westergaard et al, 1998), as well as numerous others, from spiders to naked mole rats (Shuster & Sherman, 1998). That chimpanzees use tools has been known at least since Darwin's time (Savage & Wyman, 1844, cited in Whiten & McGrew (2001)), but the uniqueness of human tool use was nevertheless still argued for another century.

<sup>2</sup>There is some anecdotal evidence even of deliberate teaching (King, 1996; McNeil, 1996).

pedigree, and the relevant fossil evidence, can be found in Johanson (2002). We share a fairly recent common ancestor with chimpanzees, some five to seven million years ago<sup>3</sup>, and slightly less recent common ancestors with various other primates, which provides a starting point for language evolution, but the continuation is not so obvious. Our relatives have their own communication systems, but it is by no means obvious whether any of these are homologous<sup>4</sup> of human language.

Among modern humans, there is no evidence that any language spoken by any group of people is in any way intermediate between “full” languages and any evolutionary predecessors. The same applies to any historically attested language<sup>5</sup>.

This lack of clear evolutionary transitional forms between non-language and language renders the elucidation of the origin of language very difficult. The focus of this thesis will be on the animal side of the apparent gap between human languages and animal communication systems, where I will review and explore the available empirical evidence. Three main questions will be investigated:

- *Animal communication in the wild* — what features characterize animal communication, and what qualitative differences, if any, are there between human language and animal communication systems?
- *Teaching language to animals* — do any non-humans acquire language, given appropriate training or rearing? Which aspects of language are most accessible to non-humans?
- *Mind and language* — what relationship, if any, is there between mind and language? What aspects of mind do non-humans possess?

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<sup>3</sup>Some, notably Arnason and associates (1996a; 1996b; 1998) at Lund University, argue for a somewhat older split, around 10 to 15 million years. On the other hand, an age below 5 million years also has its supporters (Takahata & Satta, 1997; Eastal & Herbert, 1997).

<sup>4</sup>“Homologous” is a technical term in biology, roughly meaning “similar due to shared ancestry”. It is occasionally used also in linguistic contexts (Pinker, 1998b).

<sup>5</sup>The sole claim to the contrary that I have found, Georgiev (1984, cited in an editorial comment in Jucquois (1991) ) does not appear to be widely accepted.

In all three questions, a comparative perspective is implicit. The documented abilities and achievements of non-humans are compared and contrasted with those of humans. A central question is whether the differences between humans and other animals are qualitative or merely quantitative.

## 2 Language versus other forms of communication

Language is a form of communication, and it is probable that it evolved for the purpose of communication (Pinker, 1998a)<sup>6</sup>. But it is by no means the only form of communication used in either the animal or the human<sup>7</sup> world, and language is certainly not synonymous with communication (Bickerton, 1995). Every social animal has some form or another of communication, forming a highly diverse assemblage of communication methods (Hauser, 1997), but few, if any, of these can be regarded as languages. And language also possesses additional capabilities, on top of its basic communicative purpose (Bickerton, 1995).

So what is it that is so unique about language, apart from the fact that it is *our* main method of communication? What sets language apart from all the grunts and tail-waggings and odors and whatnot that other species use? The nature of language has been contemplated by innumerable thinkers from Plato onwards; Everson (1994) gives a historical overview of Western thought on this issue, with Coward (1990) adding some Eastern perspectives. The relationship between language, thought, and mind, occupies a central role in this debate, to which we shall return in section 5, but this does not answer the question of what makes language unique<sup>8</sup>.

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<sup>6</sup>But see also Bickerton (1995), Foster (1991), and section 5 below.

<sup>7</sup>I should know; I'm working at the School of Education and Communication, Jönköping, and I am currently (1999) in charge of recruiting a professor of communication science to our school. Linguists are not prominent among the candidates.

<sup>8</sup>But then, McArthur (1987) argues that it may be a mistake to focus on its uniqueness : "*...en soulignant les notions du caractère unique du langage ..., on néglige des aspects important du langage.*" (p 157). Perhaps "what makes language unique" is the wrong question to ask?

Pinker (1998a) defines language as a system with two main components: *words* and *grammar*, a finite (though extensible) set of symbols, and a likewise finite set of rules for combining these symbols, giving us “*the infinite use of finite media*” (von Humboldt, quoted by Pinker (1998a, p 118)). This quote expresses a major part of what makes human language appear unique. Whether it actually is unique, and qualitatively different from animal communication systems, will be explored in section 3.

There is one other context in nature where it has been argued that language exists, and that is in our genetic code. This code, as expressed with DNA on our chromosomes, has some language-like properties: it has words, sort of (three-“phoneme” sequences coding for one amino acid), and it has a kind of grammar for the decoding of strings of such words, according to which some strings are grammatical and others not, and it does have the capability of “infinite use of finite media”, in its own way. But in other ways it is quite unlike human language, and its use does not remotely resemble our communication. For some different perspectives on this issue, see Botstein & Cherry (1997), Tsonis et al (1997), Bodnar et al (1997), and Sebeok (1985). Collado-Vides (1992) proposes, furthermore, that the regulation of gene expression in the cell can be treated within a grammatical formalism.

Returning to human language, McArthur (1987) focuses on the “word” component, calling language “*une technologie sémiotique*” (p 159), a theme echoed in Sebeok’s (1985) argument for semiosis as the root of language. Likewise, Deacon (1997) emphasizes the symbolic aspects of language. The distinction between symbols and other signals is important here. Following Sinha (2001), a signal can be just about any information that an organism receives, with or without communicative intent or awareness or reference. Shared reference is, in contrast, a key property of symbols: “*Conventional symbol systems are grounded in an intersubjective meaning-field in which speakers represent, through symbolic action, some segment or aspect of reality for hearers.*” (Sinha, 2001, p 4, emphasis in original). Implicit in this quote is also that symbols, unlike signals, are strictly and intentionally communicative, and

presupposes a shared awareness of the universe of discourse. But a system characterized only by joint reference is regarded by Sinha (2001) as merely proto-symbolic — the emergence of full symbolization requires *construal*, entailing the elaboration and conceptualization of the joint references of proto-symbolic systems.

Otherwise, the main thrust of modern linguistics is aimed at the grammar component. The grammatical work of Noam Chomsky (1978; 1986; 1982; 1988, among others) is of course seminal here. This has led to an emphasis on grammar as the core of language, and the principal defining feature of language.

But both words and rules are needed for a fully functional language, so the comparison with animal communication in the following sections shall explore both.

### 3 Animal communication in the wild

While language in the strict sense may be uniquely human, numerous other species have their own means of communication, many of which appear to share at least some, if not all, of the properties of language.

“The infinite use of finite media” is a crucial property of human language (Pinker, 1998a), but it is also a property of the songs of certain birds and whales, at least in the limited sense of their combining a set of elements in an infinite variety of permutations<sup>9</sup>. The majority of animal communicative acts may be non-symbolic signals, but there are examples of vocalizations where this is not self-evident (Marler, 1998, further discussed below). Hauser (1997) gives a thorough review of animal communication, in an evolutionary perspective, and Håkansson (1995) provides a popular overview.

Birdsong can, just like human language, be culturally transmitted, and geographical “dialects” are common (Wiener, 1986; Baker, 1996). Some birds appear to have an innate “song acquisition device” (Whaling et al, 1997), in analogy with the proposed language acquisition device of humans. Birds of many species need to hear the songs of other birds during a sensitive period while they grow up, or they will not develop normal singing abilities (Wiener, 1986).

But whatever similarities there may be between birdsong and human speech, they have to be produced by parallel evolution — the underlying hardware is completely different, both in the vocal apparatus (Goller, 1998) and in the brain. It is interesting for comparative studies (Wiener, 1986), but if we are looking for possible precursors of human language, we had better turn to mammals.

Whale songs are culturally transmitted as well (Whitehead, 1998; Noad et al, 2000), and some researchers argue that whale songs have something resembling a hierarchical grammar (Seife, 1999), though this remains controversial. The overall style of whale songs more resembles birdsong than speech, so their relevance for language is

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<sup>9</sup>Even the coinage of new elements has been reported for some birds (Clemmons, 1991).



not totally obvious. Gibbon songs also resemble birdsong more than they resemble language, even though gibbons are our fairly close relatives (Hauser, 2000).

The sounds produced by dolphins have more language-like features, but their quantitative study is still in its infancy. McCowan et al (1999) find promise in an information-theoretical approach, akin to Zipf's classical work on human language, but the available "dolphinsese" corpus is still insufficient for any firm conclusions. The classification and discrimination of dolphin "words" is also a non-trivial task for humans (or human-built computers), since the "phonology" of dolphins is so different from ours (Janik, 1999).

*"What do animal sounds mean"* asks Marler (1998, p 2). The traditional view, among biologists as well as linguists, has been that they have only affective meaning, expressing only the emotions of the "speaker", without symbolic referents. But numerous studies in recent decades, starting with Seyfarth et al (1980), have demonstrated that many animals use alarm calls and/or food calls, that for all practical purposes function as if they carried symbolic referential meaning.

The original study of Seyfarth et al (1980) concerned the alarm calls of vervet monkeys. These monkeys have a set of three distinct alarm calls, used for three different predators (snakes, leopards, and eagles). When a vervet monkey hears one of these calls, he or she takes appropriate action, different for each alarm call. They run for cover in bushes when hearing the eagle call, and climb up into the treetops when hearing the leopard call, and stand up to scan the grass when hearing the snake call. A purely affective call, basically conveying only that the caller was scared by a predator, could not reasonably have led to such appropriate actions. Marler (1998) also reviews some interesting data on the call acquisition of young monkeys — the calls as such appear to be innate<sup>10</sup>, but the association of a particular call with a particular predator is learned,

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<sup>10</sup>Though there exist other monkey and ape calls, where the calls themselves appear to be learned, since "dialect" differences between groups have been observed (Mitani et al, 1999; Fischer et al, 1998; Hauser, 1992; Marshall et al, 1999).

and the young monkeys start out by over-generalizing, using the eagle call for anything from falling leaves to actual eagles, and then gradually learns when it is appropriate to use the call. Adults use the call almost<sup>11</sup> exclusively when a monkey-eating bird is around.

It should also be emphasized that these monkey calls are not, as far as we can tell, iconic. They do not resemble any sounds of the predator they're referring to (Carstairs-McCarthy, 1996). This non-iconicity is a central property of human languages as well, and has been invoked as a defining and uniquely distinguishing property of human languages. Finding similar non-iconicity in animal communication further undercuts the human claim to uniqueness.

But in order to regard calls as truly symbolic, referentiality and intentionality are crucial diagnostic features, that are difficult to operationalize in wild animals. The phrase "*functionally* referential" is often used in animal communication contexts, basically in order to sidestep the contentious issue of whether animals *intend* to refer to an eagle or whatever, but retaining the implication that these calls for all practical purposes function *as if* the caller intended to warn his fellows. We shall return to the issue of communicative intent below.

Since the original work by Seyfarth et al (1980), similarly "functionally referential" calls have been observed in numerous species:

- Birds:
  - Chicken, both domestic and their wild relatives (Evans & Evans, 1999; Marler, 1998; Hauser, 1997).
  - Several species of passerines (Marler, 1998).
- Rodents:
  - Alpine marmots (Marler, 1998), but oddly enough not the closely related yellow-bellied marmot (Blumstein & Armitage, 1997).

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<sup>11</sup>The rare "mistakes" concern birds that resemble dangerous birds, but are actually safe.

- Several species of squirrels<sup>12</sup> (Greene & Meagher, 1998; Marler, 1998).
- Primates: too many to list here. Reviewed in both Marler (1998) and Hauser (1997). The list includes one lemur, numerous monkey species, and chimpanzees<sup>13</sup>.

The studies listed above concern predator alarm calls, and food calls, where it is experimentally feasible to demonstrate functional referentiality. Another field of animal symbolic thought that is experimentally tractable is that of mathematics, where numerous studies of animal counting capabilities have been performed, e.g. Matsuzawa (1985), Boysen & Berntson (1989) Maliukova & Molotova (1995), Carey (1998), Brannon & Terrace (1998), Boysen & Hallberg (2000) or Hauser et al (1996), but this is less relevant for language.

Vocalizations that are used socially are at least as numerous as alarm calls, and may be more relevant for the origin of language; see e.g. Dunbar (1993; 1996), as well as Johansson (2002). But here it is much more difficult to disentangle affective and referential uses. Cheney and Seyfarth and associates have done extensive research on the social vocalizations of baboons, finding that the baboons do extract information from the calls of their peers (more information than is evident to human ears), but that it is difficult to establish communicative intent. The grunts that are used by baboons for various purposes are analyzed by Cheney et al (1995) and Rendall et al (1999), and their “contact barks”, with the apparent function of maintaining contact between dispersed members of a group, by Cheney et al (1996).

“Communicative intent” is a central and thorny issue here. A vocalization can hardly be regarded as resembling language unless the “speaker” intends to communicate. But what does it take for an animal to *intend* to communicate? This is closely entwined with the perennial issue of mind and consciousness, since it makes little sense

<sup>12</sup>Shriner (1998) found that squirrels and marmots also respond to each other’s alarm calls.

<sup>13</sup>Hauser (1997) and Marler (1998) disagree on how solid the chimpanzee evidence is, which is rather remarkable since Marler’s sole reference on this issue is to a study by Hauser.

to speak of the intent of a being without a mind. The questions concerning animal minds are discussed in section 5 below; I will leave the main part of this issue until then.

But a few aspects of intent are clearly relevant here. One feature clearly distinguishing between language and affective vocalizations is whether the caller cares who (if anybody) is listening. Operationally, this might be measured as an observed difference in calling patterns, correlated with a difference in the potential audience. This has been found to be the case with some, but not all, of the functionally referential calls listed above<sup>14</sup>, as well as with chimpanzee and orangutan communicative use of gaze<sup>15</sup> and gestures<sup>16</sup> (Leavens et al, 1996; Leavens & Hopkins, 1998; Savage-Rumbaugh & Lewin, 1994; Bard, 1992; Call & Tomasello, 1994), but has been very difficult to establish for the social calls. Is it possible to explain such an audience effect without communicative intent? A particularly clear example may be chimpanzee alarm calls, where Byrne (2000) reports that chimps make alarm calls only when the predator is hidden from the threatened individual, not when the danger is plainly visible. Some linguists, such as Bickerton (1995), remain skeptical of any claims that animal vocalization are anything but affective. The evidence remains strongly suggestive, but not conclusive.

Martin (1998) addresses the issue of communication and referentiality from the point of view of the “listener” rather than the “speaker”. He asks “*What does it mean to claim that a word (or ... alarm call) is representational?*” (1998, p 72), and answers the question in terms of neurological processes. His answer, in short, is that the monkey’s “mental image” of an eagle should be activated not only by seeing an eagle, but equally by hearing the appropriate alarm call, in the same way that hearing a word for us evokes a

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<sup>14</sup>Including even the calls of domestic hens (Wauters et al, 1999)

<sup>15</sup>Call et al (1998) and Tomasello et al (1999) found intriguing but ambiguous results on whether chimps can use information from the gaze of others. Monkeys failed similar tests (Anderson et al, 1996).

<sup>16</sup>These studies are of captive human-raised chimps, but Veà & Sabater-Pi (1998) found that wild bonobos also use gestures, and Jucquois (1991) claims that gestures are “*un moyen de communication privilégié*” (p 22) for wild chimps.

mental image of the word's referent. This is the listener's side of the "joint reference" of Sinha (2001).

Activating a mental image is here to be contrasted with simply triggering the appropriate action, something which the monkey could do "instinctively", or due to simple conditioning, without symbolic processing. A scheme for experimentally distinguishing these possibilities is presented by Martin (1998), based on neural imaging results from human word processing<sup>17</sup>, but the appropriate experiments remain to be done with monkeys.

Some lesion studies have been performed on monkeys. One notable result is that damage to Broca's area does not affect their vocalizations, nor their gestures, implying that the human use of Broca's area for language processing is a later development, and that speech is not a direct descendant of monkey vocalizations. Instead, part of Broca's area in monkeys control chewing and other mouth motions, according to MacNeilage (1997), who invokes this functional change in support of his hypothesis of speech evolving from chewing motions. Other monkey homologs of human language areas are used for facial muscles and auditory processing, which may also be useful exaptations for language evolution (Nowak, 2000).

Concerning language beyond the level of single words, it is generally believed that the only species to have that in the wild is *H sapiens*. But, as Savage-Rumbaugh et al (1993) point out, the empirical support for this belief is not overwhelming. There are major methodological problems involved in testing whether a species uses a language-like communication system, particularly as we cannot take for granted that it would resemble our own vocal speech (Hauser, 2000). Both chimps and dolphins in the wild do manage to coordinate their behaviour in quite sophisticated ways, which is difficult to explain in the absence of a non-trivial communication system. On the other hand, the few investigations of chimp vocal behaviour in

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<sup>17</sup>Incidentally, it is interesting from an evolutionary perspective to note that neural imaging in humans has demonstrated that the primary processing of words can activate also deep ancient brain modules, that long predate the evolution of language. The amygdala is one example, playing a central role in fear and aggression and other "social" emotions in both humans and many other animals (Adolphs et al, 1998), and being activated also in the subconscious processing of threat words (Isenberg et al, 1999).

the wild that have been done (Arcadi, 2000, and references therein) have not been able to find any signs of complex language. There is, however, a considerable body of anecdotal evidence of chimps conveying fair amounts of information, by vocalizations alone, including information that couldn't have been indicated by situational cues (Savage-Rumbaugh & Lewin, 1994). In the light of the results on captive apes and dolphins (reviewed in the next section), further empirical exploration of this topic is clearly warranted. At present, we have insufficient data for any kind of conclusion.

## 4 Can non-humans be taught language?

As seen in the preceding section, there is some evidence that the natural communication systems of some animals contain units that functionally resemble the words of human language. Whether the calls are actually symbolic, or mere association-based signals that functionally resemble words, remains an open issue. But even if the ability to use and understand single words were indeed present in some non-humans, this would be a far cry from full human-style language capabilities. It is a necessary precondition for the evolution of true language, but grammar remains as a major hurdle.

It is well-known that many animals can be taught behaviour that they do not normally display in the wild, even some typically human behavioral patterns. Attempts to teach language to animals has a long history, with mixed results. Many birds<sup>18</sup> can learn to mimic human speech, but in most cases show little sign of this being anything but rote learning without understanding. Likewise, we have little reason to believe that dogs responding to verbal commands show evidence of anything beyond conditioning.

More interesting are the recent systematic attempts to teach language, in a fuller sense, to apes, dolphins, and parrots. These are particularly relevant in connection with the Chomskian linguistic paradigm, in which language, and particularly grammar, is supposed to be uniquely human, and to require a “language organ” found only in humans. If language, with grammar, could be taught to non-humans, this would falsify the strong Chomskian claims of human uniqueness, and would cast strong doubt on the existence of a dedicated “language organ”. Not unexpectedly, Noam Chomsky displays a negative attitude towards ape language research, dismissing it out of hand: “*But the question whether it [an ape] has a language faculty is a meaningless question and therefore nobody should talk about it.*” (Chomsky, quoted in Belsack et al (1999, p 35)).

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<sup>18</sup>Mammals generally do not mimic sounds like many birds do, but there is at least one case reported of a mimic seal (Deacon, 1997).

The first systematic attempt took place in the early years of this century, with an orangutan, who unfortunately died young, before much progress had been made. Later, during the 1930s, the Kellogg family tested ape learning in the environment in which humans learn language, by co-rearing a young chimpanzee, Gua, together with their own son (Savage-Rumbaugh et al, 1993). Gua kept pace with, or even outpaced, their son Donald on many tasks, including early language comprehension (but not production). But the experiment was terminated before the age of two, before either participant had really got into grammar (Desmond, 1980). A similar experiment a few years later again employed a chimp baby, Viki<sup>19</sup> (but this time no human baby). Viki, like Gua, learned to respond to a number of sentences as if she understood them, but it is unclear how much of this “understanding” was based on language, and how much on situational cues. Language production was a failure, again. Viki could articulate only a few words, with great difficulty (Savage-Rumbaugh et al, 1993; Desmond, 1980; Deacon, 1997). This limitation can be explained by the different vocal-tract anatomy and neural wiring of apes (Johansson, 2002).

In non-spoken language modalities, where the animals do possess the requisite hardware and control, teaching experiments have been much more successful (though the significance of that success is still a contentious issue). In a series of experiments, starting in the late 1960s, several apes of four different species, as well as dolphins and parrots, have been taught to use appropriate language modalities that they are anatomically equipped for:

- Chimpanzees: Rumbaugh et al (1975), Gardner & Gardner (1984), and many others
- Bonobos: Savage-Rumbaugh et al (1986, and many others)
- Gorillas: Patterson & Linden (1981), Patterson & Cohn (1990)
- Orangutans: Miles (1990, cited in King (1996) and Belsack et al (1999))

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<sup>19</sup>Or Vicki (Deacon, 1997); the spelling varies in different sources.



- Dolphins: Herman et al (1984)
- Parrots: Pepperberg and associates (1998; 1999; 2001)

## 4.1 Chimpanzees and bonobos

The pioneer here is a chimp named Washoe, with her “adoptive parents”, the Gardners (1984; 1985). Washoe was taught sign language from an early age, and learned to reproduce a large number of signs. A different modality, with abstract symbols invented for this purpose, either on physical plastic chips, or on a computer keyboard, was taught to three chimpanzees in the same time frame (Rumbaugh et al, 1975; Savage-Rumbaugh et al, 1993), with a similar degree of success. Lana and the other apes learnt to produce large amounts of more-or-less appropriate strings of symbols, in their respective modalities, which was interpreted as evidence of their linguistic prowess.

But these early experiments were severely criticized by Terrace et al (1979) who reproduced the work of Gardner & Gardner (1984) with a different chimp, named Nim Chimpsky<sup>20</sup>. Terrace et al (1979) concluded that all the “utterances” of Nim (and by extension those of Washoe and the others as well) could be explained as simple imitation, “parroting”, of the human teachers, reinforced by the rewards given to the apes for producing appropriate “words”.

Terrence et al (1979) did have a point in that the early experiments were rather lax in their methods and optimistic in their interpretations. The experimental protocols used were insufficient to distinguish between actual language learning, and the null hypotheses of parroting or the “Clever Hans” effect<sup>21</sup>. Subsequent ape language experiments were performed with modified methods and tightened controls, using blind tests and other devices, in order to circumvent the valid criticisms of Terrace et al (1979) and others.

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<sup>20</sup>Distantly related to a certain famous linguist.

<sup>21</sup>Clever Hans was a German horse, who displayed remarkable apparent mathematical abilities. But his prowess did not derive from an ability to calculate, but instead from an ability to read subtle nonverbal cues from people. It has been demonstrated that apes are similarly adept at using experimenter cues (Itakura & Tanaka, 1998).

An interesting experiment is the one with the chimps Sherman and Austin, performed by Sue Savage-Rumbaugh and associates (1978; 1980; 1994). For the first time, the chimp pupils lived in a social setting with other chimps, and the emphasis was on learning and *using* a set of symbols, rather than on producing strings of signs. Communication was in focus, and for the first time an ape experiment put as much weight on comprehension as on production. The experiment was quite successful, giving strong evidence that chimps are capable of symbolic thought and symbolic communication (Deacon, 1997), as well as communicative intent (Savage-Rumbaugh & Lewin, 1994). According to Greenfield & Savage-Rumbaugh (1984), there are some interesting similarities with the way young children handle symbols.

Sherman and Austin definitely achieved the joint-reference proto-symbolic level of Sinha (2001). This is clearly shown e.g. in the experiment described on p 79 in Savage-Rumbaugh & Lewin (1994), where Sherman and Austin are given a novel food item, and one of them chooses a symbol to use for this item. Pointing back and forth between the symbol (on a keyboard) and the item, they establish jointly the correspondance between item and symbol, and from then on both used the agreed-upon symbol for this food item.

Whether construal *sensu* Sinha (2001) was also present is a matter of interpretation, both of Sinha and of the chimps. Operationalizing construal in a controlled experiment is non-trivial, and as far as I can tell none of the controlled experiments performed with Sherman and Austin gives a clear answer on this issue.

The Sherman-Austin experiment escaped the devastating criticisms that earlier efforts had received, but instead it was argued that the abilities involved were too far removed from language to be of any relevance, because syntax was not emphasized. In the absence of syntax, the clear symbolic communication at the one- and two-word level, not only between chimps and experimenters, but also between the two chimps, was dismissed (Savage-Rumbaugh & Lewin, 1994), even though symbols are as important as syntax for language, and the clearcut evidence of joint reference in non-humans

is an important breakthrough.

What looks like another important breakthrough, came about quite accidentally in the 1980s, again in the lab of Savage-Rumbaugh et al (1985a; 1993). A teaching experiment, basically similar to those with Lana et al, was attempted with a bonobo female named Matata. Matata herself failed to learn anything notable, but her infant<sup>22</sup>, Kanzi, who had spent the language lessons clinging to his mother's fur or playing in the "classroom", spontaneously started to display signs of apparent language acquisition.

This was initially attributed to species differences; possibly bonobos were more adept at language learning than common chimps (Savage-Rumbaugh et al, 1985a; Savage-Rumbaugh et al, 1985b; Sevcik & Savage-Rumbaugh, 1994), but this does not explain the failure of Matata, who was after all also a bonobo. An alternative explanation lies in the learning framework of Kanzi, who was not deliberately taught anything, but was instead immersed in a symbol-using environment from an early age. This is unlike most of the other ape experiments (including Matata), which have not started with infants, and where the learning has been much more structured and formal. Kanzi's case has some interesting parallels to the language learning of human infants, where early exposure to language is vital, and where formal teaching is not a prominent part of the acquisition process.

These two explanations were later contrasted in a controlled experiment, where both a bonobo (Kanzi's kid sister, in fact) and a common chimp were exposed to the same kind of learning environment as Kanzi (Brakke & Savage-Rumbaugh, 1996). This experiment did show some species differences, but nothing resembling a clearcut with/without language ability contrast. And the chimp learned language significantly better in this environment than her conspecifics had done in more formal settings, so the environmental

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<sup>22</sup>Sources differ on whether he is her biological or adopted child. The official Kanzi biography, which can be found at <http://www.gsu.edu/~wwwlrc/biographies/kanzi.html>, says he's adopted (The same website also has biographies of the other apes involved with Savage-Rumbaugh et al.) As the story is told by Savage-Rumbaugh & Lewin (1994), he was practically kidnapped by Matata from his biological mother.

effect is clearly present.

Some, notably Deacon (1997), argue that the experience with Kanzi is evidence for a critical period in the language acquisition of apes, similar to that found in humans (Grimshaw et al, 1998; Batali, 1994). Savage-Rumbaugh et al (1993) further support the existence of a critical period in apes by noting that of the nine apes that they had up to then reared in a similar environment, the four who were exposed to language before the age of  $2\frac{1}{2}$  learned the use of symbols easily and naturally, whereas the five who weren't exposed to language until later in life required extensive training to make even modest progress.

But, as further argued by Deacon (1997), this raises a perplexing problem. The critical period is generally taken to be an attribute of the innate language acquisition device of the Chomskian paradigm, so if apes display a critical period, this would be evidence of their having a language acquisition device. But why would apes, who do not, as far as we can tell, acquire language in the wild, possess a *language* acquisition device, dormant for millions of years until human scientists came along? Parallel evolution of a complex device that isn't used is evolutionarily ridiculous. More reasonable is the hypothesis that the common ancestor of humans, chimps, and bonobos already possessed those components of the device that we have in common. This implies one of the following three possibilities:

- Chimps and bonobos do use and acquire language in the wild, with a language acquisition device that's a shared inheritance from our common ancestor. This cannot be totally excluded, but there is no real evidence in favor of it either. Of course, if this possibility is correct, then the whole controversy over Kanzi and his friends is moot.
- This common ancestor already had language, which was then subsequently lost in the chimp/bonobo lineage, with some vestiges of the language acquisition device retained. But why would they lose something so obviously useful?
- The "language" acquisition device isn't language-specific, but

is a more general learning device, used by the common ancestor, and still by the chimps, for some purpose other than language.

As long as we have no evidence of language acquisition among apes in the wild, the third possibility appears most likely. This means that if the existence of critical periods in apes is confirmed, the case for a Chomskian uniquely human language acquisition device is weakened, whereas the competing hypothesis of language acquisition using a more general learning device would be strengthened. But the data available so far on ape language acquisition at different ages would be statistically insufficient even if it were uncontested.

Another aspect of language where Kanzi and his friends excel, by ape standards, is the comprehension of spoken English. Comprehension experiments are often vulnerable to the Clever Hans hypothesis, but experiments with Kanzi and a few others have been done under circumstances<sup>23</sup> where it is hard to escape the conclusion that they actually understand even syntactically non-trivial spoken sentences. Kanzi has, for example, demonstrated in blind tests comprehension (as evidenced by correct action<sup>24</sup>) at the 70%–80% level of sentences like “Give the lighter to Rose” or “Go get the carrot that’s in the microwave”<sup>25</sup>. This is marginally *better* than the performance of a two-year-old human child in the same experiment

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<sup>23</sup>The methodology is described in detail in Savage-Rumbaugh et al (1993), and appears as watertight as is reasonably possible, consistent with ethical and practical considerations (Bates, 1993).

<sup>24</sup>A non-negligible fraction of the remaining 20% - 30% may simple be due to him not being in the mood for yet another silly request — in experiments with apes, as with young children, getting and keeping their attention and cooperation is a non-trivial problem. As Bates (1993) puts it: “*I sometimes wonder whether we are working towards a rich theory of language comprehension in the docile child — a theory that may not extend to their more rambunctious peers.*” (p 230), a quote that applies even more to ape studies.

<sup>25</sup>It might be worth noting that this sentence contains an example of recursivity, albeit minimal. Kanzi’s successful parsing of this structure is interesting particularly in the context of the arguments of two proponents of language as innate and uniquely human, Hoekstra & Kooij (1988). After grudgingly admitting that some progress has been made in teaching apes to use symbols, they go on to argue that the recursivity of human language is forever out of reach for apes: “*Both systems [language and counting] are recursive, and neither is accessible to apes. ... This difference in the capacity for handling recursive systems is not a quantitative matter: one either has it or one doesn’t. The fact that all languages are characterized by this recursive property reflects a predetermined faculty of the species ...*” (Hoekstra & Kooij, 1988, p 33). Their claim that counting is inaccessible to apes is dubious as well — see p 11.

(Savage-Rumbaugh et al, 1993; Belsack et al, 1999). Kanzi's sensitivity to word order reversals ("Put the juice in the egg" versus "Put the egg in the juice") was likewise significantly better than chance (as well as better than his human competitor). He has also shown his ability to carry out multi-step instructions received through a telephone<sup>26</sup>, with no person physically present aware of the details.

Comparing details in the performance of Kanzi with that of Alia, his human co-subject, it can be observed that there are some significant patterns. Contrary to expectations, Kanzi is the one to excel on sentences where syntax is the key, whereas Alia outperforms Kanzi on those sentences where the syntax is simple but short-term memory may be a limiting factor (Savage-Rumbaugh et al, 1993).

According to Belsack et al (1999) and Savage-Rumbaugh & Lewin (1994), Kanzi's own production also displays hints of syntactical structure, with consistent word order, on the same level as a child at the two-word stage of language acquisition. The word order is determined by constituent roles, rather than by the specific words, as in human grammars — *Agent-Action* and *Action-Patient*, rather than e.g. consistently putting object names first regardless of their thematic role (Savage-Rumbaugh & Lewin, 1994).

The rate of word-learning by Kanzi and his sister was measured by Lyn & Savage-Rumbaugh (2000), and was found to be quite competitive with that of young human children. The apes were capable of mapping new (invented) words onto objects with only a modest number of trials, even without visual contact with the objects.

## 4.2 Gorillas

Very impressive results appear to have been achieved with the gorilla Koko (Patterson & Cohn, 1990; Patterson & Linden, 1981). Unfortunately, the story of Koko's apparent language acquisition

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<sup>26</sup>It is interesting in itself that he appears to understand that the voice in the telephone is actually a human elsewhere, and not just a talking box.

is not stringently documented and controlled, so the earlier criticisms of Terrace et al (1979) still apply (Tof, 1996). This lack of stringency is unfortunate, since remarkable abilities are reported for Koko, that would lead to very interesting conclusions if they could be corroborated. These abilities include communicative competence close to that of Kanzi, but also things like the production of representational art and the reporting of what a work of art is supposed to represent, and an IQ well within the human range as measured by standard IQ tests.

There are also reports of a gorilla group in captivity spontaneously developing a system of gestural communication (Taylor-Parker et al, 1999).

### 4.3 Dolphins

The dolphin experiments of Herman et al (1984) are quite different from the various ape experiments, in that they focus entirely on comprehension rather than production. Two dolphins, Phoenix and Akeakamai, were taught to respond to sentences in two different artificial languages, one sign language (with a human doing the signing at the edge of the pool) and one whistle language (with a computer doing the whistling, through loudspeakers in the pool), each with its own well-defined grammar. The grammar was quite simple, but did possess features like word-order dependence, in order to test whether the dolphins were sensitive to syntax as well as semantics. All sentences were in the imperative mood — instructions for the dolphins to perform various actions — so they lacked explicit grammatical subjects, but could have both direct and indirect objects. Phoenix was trained with the basic word order DirectObject + Action + IndirectObject, and Akeakamai with IndirectObject + DirectObject + Action. Modifiers to both objects and actions were used as well. Some actions had only a direct object, others had both types of objects. The same items could be used in either object position, so that both sentences in syntactic minimal pairs like *HOOP FETCH PIPE* (“Fetch the hoop to the pipe.”) and *PIPE FETCH HOOP* (“Fetch the pipe to the hoop.”)

were used and correctly acted upon.

The experiments were successful, in the sense that the dolphins learned to respond correctly to sentences in their respective languages. Testing the dolphins was done with a protocol containing reasonable precautions against the Clever Hans effect and other problems that have cast doubt on many ape results.

Their performance is high above chance level, also in the case of novel sentences that have not appeared in training. Typical success levels are in the 80%+ range for both dolphins. Even in semantically reversible sentences, where a correct interpretation of the syntax is vital, the dolphins performed well, with Phoenix achieving 77% entirely correct actions and Akeakamai 59% entirely correct. The incorrect responses were rarely due to sentence reversal — the direct object was correctly identified in 90%+ of the reversible sentences for both dolphins, clearly demonstrating that the dolphins are sensitive to word order.

With the description given in Herman et al (1984), it is difficult to interpret their results without postulating both semantic-symbolic and syntactic abilities in the dolphins. The success with both dolphins, using different modalities and different grammars, indicates that dolphins are capable of learning arbitrary rules and symbols. The sign language consisted of largely iconic symbols, but the whistle language did not<sup>27</sup>. The whistle language resembles the modality of natural dolphin communication, but the sign language does not. Despite these contrasts, both were roughly equally learnable.

The performance of these dolphins is quite competitive with that of Kanzi, or for that matter that of human two-year-olds, on similar tests. However, as the experiments focused entirely on comprehension, with no production and no dialogue, only abstract language-

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<sup>27</sup>There are two caveats to be raised here, due to the very different sensory world of dolphins. It is not self-evident that gestures by humans that appear iconic to humans also do so to dolphins, who lack gestures and limbs to gesture with themselves. On the other hand, given the major use that dolphins make of sonar, it is not self-evident that whistles that do not appear iconic to humans, may not be iconic for dolphins, possibly resembling sonar echoes from the items in question. However, given that all whistles used, with the exception of the dolphins' names (for which their own signature whistles were used), were invented by humans, any such whistle iconicity would be accidental.



like skills were tested, and not any social communication. The choice of modalities is perhaps unfortunate, as two-way communication with humans is impossible in both cases — the sign language is anatomically impossible for dolphins, for obvious reasons, and the whistle language is partially outside the range of human hearing. An experiment where dolphins were immersed in a social and communicative language-using environment, in a paradigm similar to those that have been highly successful with apes and parrots, would be very interesting.

Further experiments with dolphins would clearly appear warranted, but are even more cumbersome and expensive than ape studies; to the best of my knowledge this dolphin study has not been replicated.

#### 4.4 Parrots

Irene Pepperberg and associates (1998; 1999; 2001) have taught a number of Grey parrots, *Psittacus erithacus*, to communicate with humans, using English words. Their star student is Alex, whose achievements rival those of many of the mammals described above. Among his apparent abilities are:

- Correctly labeling a fair number of objects
- Appropriately using hierarchical concepts, e.g. “Color”  $\mapsto$  {“Blue”, “Green”, “Red”, etc }.
- Appropriately using simple expression frames like “Want X” or “Wanna go Y”, substituting labels for X and Y that appear to correspond to his desires.

The training regime used is emphasized by Pepperberg (2001) as crucially important to the success of her experiments. Unlike earlier and less successful parrot experiments, where standard conditioning techniques were used, Pepperberg and associates are using a social interaction paradigm, with a “Model/Rival” technique at its core that mimics typical social interactions of these parrots in the wild.

There are interesting parallels to be drawn with the ape studies described above, where more naturalistic and spontaneous learning in a social-interaction context, as with Kanzi and his friends, has been clearly more successful than conditioning and systematic training, in developing usable language-like communication skills.

## 5 Language, mind, and consciousness

What is the mind, and what does it mean to be conscious and self-aware? These are questions with an ancient and distinguished philosophical pedigree, going back at least to Aristotle, but without universally accepted answers. These concepts are relevant to the issue of language origins and animal language, because it has been argued that language and mind are intimately connected (e.g. Maturana et al (1995), Jonker (1987)). A necessary connection between mind and language has been proposed in both directions, either with language a necessary prerequisite for conscious thought<sup>28</sup> (Bickerton, 1995; Spangle & Menzel, 1991), or with self-awareness and intentionality a necessary prerequisite for symbolic thought and true language (Sinha, 2001; Zlatev, 2001).

Pinker & Bloom (1990) and Bogen (1997) argue strongly against normal human language being the basis for thought, as does Zlatev (2001) for consciousness: “..., *language can not be the major cause of (self-)consciousness as is claimed by numerous contemporary theorists (e.g. [...]), since its acquisition presupposes (a degree of) intersubjectivity, which presupposes consciousness.*” (2001, p 6, emphasis in original)

Furthermore, a strong connection from language to mind implies that young children, as well as aphasia patients, are mindless, an implication that does not agree with our experiences, nor with empirical data from patients with total agrammatic aphasia (Bloom, 2000), and even language-less left-hemispherectomized patients (Bogen, 1997). For that matter, looking introspectively I can state with confidence that not all my own thoughts are language-based — images and other pseudo-sensory patterns form a conspicuous part. And I am in good company here: “*Words and language, whether written or spoken, do not seem to play any part in my thought pro-*

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<sup>28</sup>The idea that language is required for conscious thought has the remarkable corollary that there must have existed people with language but without consciousness. Julian Jaynes (1976), reviewed in Mooneyham (1993), takes this idea to its logical extreme, postulating non-conscious people as late as the Bronze Age. While Jaynes’ specific proposal is ludicrous, the reasoning behind it is nevertheless a valid deduction from language as a prerequisite for consciousness.

*cesses. The psychological entities that serve as building blocks for my thoughts are certain signs or images, more or less clear, that I can reproduce at will.*” (Albert Einstein, quoted in Dehaene et al (1999, p 970)).

Still, there are reasonable grounds for suspecting some kind of connection between language and mind, at least in the direction from mind to language — symbolic language makes little sense without intentionality and self-awareness.

Humans are arguably better than other animals, both at communicating, and at understanding intentionality and mind in others. And even without one being a strict prerequisite for the other, it is pertinent to ask whether our edge in communication is caused by our edge in “mind-reading”, or vice versa? Or are both abilities emergent from some underlying general feature of the human mind? Are the differences between human minds and the mental processes of other animals qualitative or quantitative?

## **5.1 What is Mind — the “hard problem”**

The mind, as used in this context, corresponds roughly to the non-theological aspects of the soul concept, the grammatical subject of “*cogito, ergo sum*”, but it is not easy to define the mind in any stringent way, much less operationalize the concept. See e.g. the reviews of Hofstadter & Dennett (1982) and Ran (1999) for a variety of perspectives. The debate surrounding the brain and mind has close parallels with the classical body-soul duality. Is our perception of being a self-aware mind (or soul) merely an epiphenomenon growing out of various brain activities, or does the mind have an existence beyond mere neuronal patterns in the brain? And if it does, what is its substance, and what is its connection with the material world? This is the essence of the “hard problem” of consciousness. The hard problem is beyond the scope of this thesis, and I will just briefly touch upon a few aspects of it that may be relevant to the phylogenetic origins of the mind.

Lindahl (1997) discusses the evolutionary implications of different views of the relation between the mind (or “mental events”) and the brain (“neural events”). “Mental events” are essentially our conscious thoughts and decisions, as perceived by ourselves in introspection, and “neural events” are whatever is going on in the brain when a mental event occurs — for example, when I consciously decide to raise my right arm (a mental event), the corresponding neural event is the brain activity that ends up in motor commands going out from the brain to the arm muscles.

Lindahl (1997) distinguishes between three<sup>29</sup> possible relations between mental and neural:

- *Epiphenomenal*. Neural events are real, and cause e.g. bodily actions. Our perception that mental events cause actions is an illusion. To the extent that mental events exist, they are caused by the neural events as a mere accidental byproduct.
- *Interactional*. Mental events are real, and interact with, and can cause, neural events and subsequent physical actions. The interactional view can be further subdivided (Vanderwolf, 1998):
  - The Aristotelian view, in which the mind is primary. All functions of the body (and brain) are directly due to the mind.
  - The Cartesian dualism, in which the mind and body form a symbiotic system, with bodily functions handled mechanically but higher functions (notably language) handled by the mind. In the Cartesian view, only humans have minds — animals are mindless automata, purely mechanistic.
- *Identity*. Mental events *are* neural events. Our perception of consciousness is a neural pattern, and nothing else (Dennett, 2001).

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<sup>29</sup>Sampson (1999) presents a fourth alternative, that mind is a social construction, “*distributed among individuals, the texts they produce, the artifacts they create, and the institutions they develop*.” (p 1). However, in my judgement her alternative does not add anything useful to the present discussion.

Unfortunately, it is very difficult to get any empirical handles on these alternatives. Both Lindahl (1997) and Århem & Liljenström (1997) attempt to apply evolutionary reasoning, with the following basic steps:

- Humans have minds (whatever they may be).
- Not all living things have minds, so minds must have evolved somewhere along the human family tree.
- Minds are complex features, the kind of features that don't just turn up by accident in evolution, but must confer a selective advantage.
- Features that don't *do* anything can't give a selective advantage.
- The only alternative in which the mind does do something that may confer a selective advantage is the interactional perspective, in which the mind is real, and materially affects the brain and body. In the other alternatives, the mind does not affect anything else, and so cannot confer an advantage.

Both authors conclude that this argument makes a strong but not compelling case for the interactional view. What makes the argument inconclusive is that we cannot rule out the possibility that what is really selected for is a particular type of complex brain activity, of which our perception of having (being?) a mind is a mere byproduct, a spandrel.

An argument in the other direction comes from the fact that there are clear causal links from neural events to mental events. At a basic level, it is uncontroversial that there is a causal link from light absorbed in the retina (a neural event) to our perception of light (a mental event). But on a higher level, the fact that our minds can be affected by brain lesions, and by mind-altering drugs (through well-defined neurophysiological mechanisms), is good evidence that the mind is causally dependent on the brain, and not vice versa. Also the timing of events are evidence against a causal

link from mental to neural. It is reported by Georgieff & Jeannerod (1998) that mental events (as reported verbally) significantly lag behind the corresponding neural events, more than can be accounted for by speech processing time lags. Together, this rules out the Aristotelian view, and weakens the case for dualism.

## 5.2 What is mind — the “easy problem” — and do animals have it?

We now leave the ultimate nature of Mind aside, and proceed with more tractable aspects of consciousness, that are empirically accessible also in non-humans. These aspects include both the neural events associated with consciousness, and the inferences about mental events and self-awareness that may be drawn from observed behavior.

The neural events that indubitably take place while we introspectively perceive mental events, are considerably easier to operationalize and study experimentally, than the mental events themselves. But even here there are vexing difficulties in correlating neural and mental events — neural events can be measured, but how do we know that a mental event has taken place in somebody else’s head? Vanderwolf (1998) discusses this problem at some length, concluding simply that we can’t know. We can only judge by external behavior (including verbal reports of purported mental events<sup>30</sup>), but this may not be sufficient — see the Chinese Room parable of Searle (1980) for an extended argument against inferring mental events from external behavior.

On the other hand, in everyday life we do infer mental events from the external behavior of others<sup>31</sup>. We assume that other humans have a mind, and have mental processes that resemble our own, and we use our understanding of mental processes to predict their behavior. This ability to infer mental events is important

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<sup>30</sup>See Lubinski & Thompson (1993) for a review of the communication of mental (or “private”, as they call them) events, in both humans and other species.

<sup>31</sup>The Turing Test (Hofstadter, 1982) is an interesting generalization of this inference, to non-human and even non-living minds.

enough to have a name of its own — we are said to possess a “theory of mind” (Premack & Woodruff, 1978, cited in Povinelli (1993)). Without a theory of mind — an understanding that other humans have minds like our own — we would be unable to function socially. An innate theory-of-mind module has been postulated (though the evidence is not conclusive), and theory-of-mind defects have been invoked as the main cause of autism<sup>32</sup> (Baron-Cohen et al, 2000, but see also Parisse (1999)).

Whether somebody possesses a theory of mind *is* an experimentally tractable question. And it is reasonable to assume (though not a stringent certainty) that a being with a *theory* of mind also possesses a *mind* of its own — how else can it infer the presence of minds in others, if it doesn’t have one of its own to compare with? Never mind the philosophical issues for the moment — this argument needs only a mind in the sense that we perceive ourselves as having, whatever its ontological status.

Experiments testing for the possession of a theory of mind have mainly been conducted on human children, e.g. Feinfeld et al (1999), in whom the existence of a mind is taken for granted. It has been found that children develop a theory of mind through several regular stages at roughly predictable ages, much like language acquisition (Lee et al, 1999), starting with an important breakthrough around an age of 9 months (Zlatev, 2001). Of course, the acquisition process is beset by the same ontological issues that were discussed above (Montgomery, 1997) but normal children nevertheless manage to acquire a theory of mind in about the same time it takes for them to acquire language. This may be taken as a sign that there is a connection between language and theory of mind — but a patient with agrammatic aphasia, totally lacking syntax, nevertheless had a full theory of mind (Bloom, 2000). Reports also exist of deaf children who grew up without useful language input (Goldin-Meadow & Mylander, 1998) — there is some evidence that their

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<sup>32</sup>Classical autism is commonly accompanied by general retardation (Wong, 2001). Asperger’s syndrome is in many ways similar to autism, but without retardation — rather the opposite. Asperger patients appear to have the same theory-of-mind deficits as autists, but have sufficient general intelligence to overcome the deficit by using heuristic strategies, applying brute-force logic to compensate for the innate social understanding that they lack (Ben Shalom, 2000).



theory-of-mind acquisition is delayed, but not absent (Tomasello, 1999).

More interesting in this context are the experiments that have been conducted on beings that do not normally acquire language, and whose possession of a mind is in some doubt. After the seminal paper of Premack & Woodruff (1978), a number of groups have attempted to determine whether non-human primates have a theory of mind. The experiments themselves are very similar to the experiments done with pre-verbal children, testing for behavior based on inferences about the mental state (knowledge and intentions and motivations) of other beings, either conspecifics or experimenters. Heyes (1998) reviews the the field, as it was twenty years after the work of Premack & Woodruff (1978), and concludes that it is very difficult to design experiments which can firmly exclude non-mind interpretations, and that the data available are inconclusive. In a later review, Pennisi (1999) is more positive, unlike Tomasello (2000) and Hauser (2001) in his popular but solidly researched book *Wild Minds*.

As research with human children has shown, a theory of mind is not a monolithic module that you either have or not — instead it is acquired gradually, with more and more abilities to reason about the mental states of others being added. Apes regularly fail tests for the “higher” abilities, such as an understanding of false beliefs<sup>33</sup>, that children don’t acquire until age 5 or so. But both apes and monkeys have considerable “social intelligence” (Anderson, 1998), and a thorough understanding of the politics of a primate tribe (de Waal, 1998; Strum, 1989), which is difficult to explain without assuming an understanding that the others in the tribe are also active participants. But political astuteness is not easily amenable to experiments in laboratory settings, unlike lower-level functions that are more experimentally tractable. One such lower-level function is gaze-following — does an ape (or a child) notice in which direc-

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<sup>33</sup>Bloom & German (2000) argue that the false belief task is not a relevant test for the possession of a theory of mind, since passing the test entails other abilities as well. The argument of Bloom & German (2000) is supported by the discovery of Abu-Akel & Bailey (2001) that success on false-belief tasks is strongly dependent on the presentation of the task, notably in the degree of symbolic thinking required.

tion somebody else is looking, and infer that something interesting must be in that direction? This is one of the first mind-related abilities acquired by humans, before age 18 months, and several experiments have been performed with apes and monkeys. The results are mixed, in that some experiments, e.g. Anderson et al (1996), failed, whereas others, e.g. Tomasello and associates (1998; 1999), met with better success. It is conceivable that the difference can be attributed to the fact that Anderson et al (1996) worked with rhesus monkeys, whereas the strongest successes of Tomasello et al (1999) have been with chimpanzees. On the other hand, Povinelli et al (2000) also find evidence of chimpanzee gaze-following, but do not attribute it to a theory of mind — the pattern of behavior is such that non-mentalistic explanations cannot be excluded. Tomasello et al (1999) conclude “*The degree to which chimpanzees have a mentalistic interpretation of the gaze [...] of others is still an open question.*” (p 769), which is a conclusion that can be applied to the entire field of theory-of-mind studies in apes.

Another aspect of the mind is self-awareness. This is another concept the presence of which is experimentally difficult to assess, but Gallup (1985) proposed the following test:

1. The subject is placed in a room with a mirror, and is given time to get acquainted with how a mirror works.
2. The subject is rendered unconscious
3. A marker that cannot be felt is placed on the body of the subject, in a place where it cannot be seen directly. A drop of paint on the forehead is commonly used.
4. When the subject wakes up, there is only one way for the subject to discover the mark — by using the mirror. Operationally, this is measured by observing whether the subject tries to scratch or rub away the mark, before and after having seen it in the mirror, and if the rate of mirror use increases when the mark is detected.
5. Scratching a mark on your own body, after seeing it in the

mirror, implies that you understand that the image in the mirror is an image of yourself. And this in turn implies that you understand that you *have* a self — which is pretty much the definition of self-awareness.

The mirror test for self-awareness has been used extensively in the years since Gallup proposed it, both by Gallup himself, reviewed in (1998), and many others. Humans manage the test from the age of 2 or so (Hauser et al, 1995). Concerning chimpanzees, there is near-unanimity that they succeed in the mirror test (Lin et al, 1992; Kitchen et al, 1996; Povinelli et al, 1997, among others), with about half of a total of 163 tested chimpanzees apparently recognizing their mirror-image (van den Bos & de Veer, 2000). The success of other apes is more mixed, with considerable doubt remaining about the abilities of gorillas in particular (Shillito et al, 1999), but it appears that at least some gorillas and orangutangs pass the test (Taylor-Parker et al, 1999; Hauser et al, 1995; Tobach et al, 1997). It is interesting to note that to date, the only gorillas to pass the test have been human-reared participants in language-learning experiments, such as Koko (see p 22), whereas gorillas growing up without intimate human contact consistently fail (van den Bos & de Veer, 2000).

Outside the hominoids, successful mirror tests have been reported for cotton-top tamarins<sup>34</sup> (Hauser et al, 1995) and recently also for dolphins (Reiss & Marino, 2001) and killer whales (Delfour & Marten, 2001). In humans, brain scans have located several brain areas that are activated specifically by self images, but not by viewing images of others (Kircher et al, 2001) — replicating this experiment with apes would be interesting.

Heyes (1996) remains skeptical also of the mirror test, as she is of theory-of-mind experiments (Heyes, 1998), mainly invoking methodological concerns. Both Mitchell (1995), Povinelli et al (1997) and van den Bos (1999) address her concerns, and the latter two

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<sup>34</sup>The tamarin is a small South American monkey, only distantly related to us hominoids. Given that African monkeys, much more closely related to us, consistently fail the mirror test (van den Bos, 1999), the success of the tamarin is rather odd, and would benefit from replication.

present new data which firmly exclude the alternative interpretation proposed by Heyes (1996). In conclusion, it appears well established that at least some non-humans can recognize themselves in a mirror, from which some level of self-awareness can reasonably be inferred.

The issue of self-awareness raises the issue of what the self is. Disregarding philosophical and theological complications, introspection tells me that a large part of what makes me *me* is my memories, and my self-awareness is to a considerable extent built from my awareness of my memories<sup>35</sup>. Animals of all kinds certainly have memories — but are they consciously aware of what they remember? In an ingenious sequence of experiments, Hampton (2001) has determined that monkeys are. Rhesus monkeys were faced with the task of remembering which of a set of test pictures they had seen before — but they were given the opportunity to refrain from taking the test, with suitable incentives so that the wise course was to take the test when they remembered, and decline otherwise. Rational choice here is possible only for beings who are *aware* of their memories, and able to “look at” their memories and evaluate if they’re good enough for the test. The monkeys did choose rationally, which can reasonably be interpreted as their being consciously aware of their memories (Hampton, 2001; Griffin, 2001), which opens the possibility of their building a sense of self, in the same way as we do.

Interestingly enough, Gusnard et al (2001) have found (in humans) a specific brain area, in the medial prefrontal cortex, that is activated in the kind of introspective tasks that the monkeys above were engaged in — to the extent that the self is a matter of brain activity, this may be its location in the head. Similarly, some progress has been made in identifying what it means, neurally, to pay conscious attention to something (Stryker, 2001; Pascual-Leone & Walsh, 2001).

In conclusion, it does appear as if apes, and possibly some monkeys, do show the external signs of possessing at least a subset of the

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<sup>35</sup>Note that “memory” is not a homogeneous concepts — there are several types of memories, not all of which are connected with awareness (Schachter, 1998; Clark & Squire, 1998). I am here referring primarily to the type called “declarative memory”.

features that we humans have, and that we label as our minds. The features detected in apes correspond to those that develop early in human ontogeny — this may be interpreted as a case of ontogeny recapitulating phylogeny (Povinelli, 1993).

The presence of some aspects of mind in apes does not support the view that language is required for thought and consciousness. Instead, the evidence indicates a gradual evolution of the mind, possibly along the lines sketched by Povinelli (1993), with metacognition, reviewed in Nelson & Rey (2000), as the central theme — cognition about cognition, the ability to think about one’s own thoughts, is regarded as the core of the self-aware mind. A key concept here is *attention*, directing the metacognition at some particular underlying cognitive event (Posner, 1994). A related conception of the mind is the “higher order thought” hypothesis of Rosenthal (2000), but Dennett (2001) paints a different picture, where consciousness is the result of a “political” battle for influence in the brain between competing neural processes.

## 6 Conclusions

In the preceding sections, I have attempted to gather and review the available evidence that addresses the three main questions of this thesis:

- *Animal communication in the wild* — what features characterize animal communication, and what qualitative differences, if any, are there between human language and animal communication systems?
- *Teaching language to animals* — do any non-humans acquire language, given appropriate training or rearing? Which aspects of language are most accessible to non-humans?
- *Mind and language* — what relationship, if any, is there between mind and language? What aspects of mind do non-humans possess?

It is clearly established that animal communication in the wild is more complex and multifaceted than the simple affective squeaks and grunts of the traditional view. Many different species use vocalizations that carry other types of information than affective calls do, that only inform of the emotional state of the producer.

The paradigmatic example is the alarm calls of vervet monkeys; when a monkey notices an eagle, he or she emits the “eagle call”. Upon hearing the eagle call, other monkeys act as they would if they themselves saw an eagle, and run for cover. This looks very much *as if* the first monkey intends to warn the others, and *as if* the other ones understand that the call *means* “Eagle!”. It is, however, very difficult to operationalize and empirically disentangle different senses of the word “means” here, different levels in the hierarchy of meaning of Zlatev (2001). Zlatev himself places the monkey calls at the level of association-based meaning, but a higher level is far from excluded by the data. The calls are, as far as we can tell, both conventional and shared among the monkeys, and the monkeys do show the rudiments of communicative intent, in that their calling is

contingent on the presence and actions of other monkeys. But the system is not easily extensible with new calls, and the monkeys do not appear to be able to apply the known calls in any contexts but that of immediate eagle alarm.

In conclusion, the calls of many non-human animals display a mixture of features, making it possible to interpret them as either signals or (proto-)symbols. The available evidence is insufficient to distinguish these possibilities, but enough hints of symbolicity are present to warrant further research, and to make the common assumption that humans are the only symbolic species less self-evident. There is no unambiguous evidence of qualitative differences between human words and all non-human vocalizations.

In language teaching experiments, impressive progress has been made in establishing the capacity for at least rudimentary forms of “uniquely human” cognitive and communicative skills in both apes and dolphins and possibly parrots. The dolphins and parrots, however, are phylogenetically distant from us, and the Mesozoic common ancestors that they share with us clearly did not have anything remotely resembling their current cognitive capacity. This implies that their communication abilities are the result of parallel evolution, and thus tells us little directly about the origins of human language. However, it is interesting to note that all animals that have had any kind of success in this type of experiments belong to highly social species with complex group interactions, something which may hint at social processes as a driving force behind the evolution of language, an idea further pursued in Johansson (2002).

Of more direct relevance for the origins of human language are the experiments performed with non-human apes. Whether the skills acquired by these apes should be regarded as language-related is still hotly contested, but the achievements of Kanzi and his friends leave less and less room for reasonable doubt that at least some aspects of language are within reach of non-humans. A strong case can be made for the existence of symbolic thought in apes, and the use of symbols that are referential in the same sense of conventional shared meaning as human words. The case for syntax acquisition by

non-humans used to be weaker, but the achievements of both Kanzi and the dolphins are hard to explain without them understanding syntax.

Pinker (1995) discusses the key issue of whether the abilities displayed by chimps are homologous to human language. He concludes that “[t]hrough artificial chimp signaling systems have some analogies to human language (...), it seems unlikely that they are homologous. Chimpanzees require massive regimented teaching ... This contrasts sharply with human children...” (p 3, online edition). Pinker (1995) certainly has a point in so far as the earlier ape language experiments are concerned — but his criticism does not directly apply to Kanzi and his successors, who acquired apparent language abilities spontaneously, without the massive teaching that earlier apes had received. This is seen already in the title of the paper presenting Kanzi to the scientific world: “*Spontaneous symbol acquisition and communicative use by pygmy chimpanzees (Pan paniscus)*” (Savage-Rumbaugh et al, 1986).

So what would the presence or absence of rudimentary language and syntax abilities in apes tell us?

- Its *absence* would actually tell us very little (Pinker & Bloom, 1990), other than constraining the time frame for the origin of language to the time since our last common ancestor with chimps. It would be a corroboration (*sensu* Popper (1963)) of the hypothesis of a unique dedicated language system, but a very weak one. It would not really help us understand its evolution.
- Its *presence*, on the other hand, would be quite informative. *Any* language acquisition by apes would falsify the notion that language is uniquely human, and bridge the last apparent gulf between us and other animals. And detailed information on what the apes can and cannot do with language would strongly constrain theories about the evolutionary path of our language abilities.



The patterns observed in direct comparison between human and non-human language acquisition are intriguing:

- Systematic training of non-humans within a conditioning paradigm has met with very limited success

*but*

language acquisition in a social communicative context works much better.

- Adult apes that were not exposed to language at a young age, are poor language learners

*but*

apes immersed in language from a tender age are much more successful.

- Non-human acquisition is often a slow and tedious process in the beginning

*but*

after some threshold is passed, learning can be much more rapid and human-like (Pepperberg, 2001; Lyn & Savage-Rumbaugh, 2000).

- When an ape (Kanzi) was directly compared with a human child with similar communicative and general cognitive skills, the human child out-performed Kanzi on list-type sentences (“Get the apple and the orange and the banana”)

*but*

the ape out-performed the human on word-order sensitive sentences, where syntax would appear to be the key.

The first two points indicate similarities between the acquisition process and optimal acquisition environment between apes and humans. It is very unlikely that a human child would acquire normal language skills in a conditioning paradigm, whereas the social immersion paradigm that is routinely and successfully used among

humans is successful also with apes<sup>36</sup>. Likewise, humans, such as Genie (Goldin-Meadow, 1982), that are not exposed to language in early childhood also fail to acquire normal human language. Neither of these points indicates any qualitative differences in the acquisition process. It is rather the similarities that are striking.

The third point concerns the considerable quantitative differences in early acquisition rates between humans and non-humans. The occasionally observed transition to a higher learning rate indicates that a qualitative difference in the learning process may be involved — but that this qualitative difference may be bridged also by some non-humans, after some linguistic threshold has been passed. Pepperberg (2001) indicates that a similar transition occurs also in humans, though at a much earlier stage in ontogeny. Again, there is no clear evidence of any qualitative differences between human and non-human acquisition, merely a quantitative difference in the timing of and possibly requirements for the apparent transition.

The fourth point directly contradicts the commonly held views that syntax is the core of what makes human language unique, and that syntax acquisition is impossible without an innate grammar. If syntax were uniquely human and innate, a human and an ape with similar general communicative skills could be distinguished by the *human* excelling at syntax-based tasks. Instead, the opposite pattern is found. Again, there is little evidence of any qualitative differences between human and non-human.

Further experiments are needed for firm conclusions. But, even though skeptics remain, the preponderance of the evidence is clearly on the side of presence, rather than absence of basic language skills in some non-humans. When a young child displays the same apparent abilities as Kanzi, we do not hesitate to say that the child is acquiring language (Savage-Rumbaugh & Lewin, 1994). Is a double standard sometimes employed?

The study of parallels between human language and animal communication, is not popular among all linguists: “*There is a long his-*

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<sup>36</sup>Though it may be noted that the dolphins of Herman et al (1984) acquired apparent Kanzi-like comprehension skills under what was essentially a conditioning paradigm.

*tory of study of origin of language, asking how it arose from calls of apes and so forth. That investigation in my view is a complete waste of time, ...*” (Chomsky, 1988, p 183). Other linguists as well have expressed similar disparaging sentiments, about which ape language pioneer Sue Savage-Rumbaugh (1998, p 1) asks bluntly: “*Why are we afraid of apes with languages?*”

Do we need to be? Would not our world be richer if they did have minds and language, not only for the light that would be cast on our own origins, but also just for the company — *Homo sapiens* would no longer be alone in this huge and mostly inhospitable universe.

But for company, we need not only beings with language, but also beings with minds of their own, which brings us to the third main question, concerning the relation of language and mind, and the possible presence of mind in non-humans.

It appears quite clear that a causal link *from* language *to* mind and consciousness is unlikely, as language in the full sense of symbolic communication appears to require both a mind and an awareness of mind in others, and is preceded ontogenetically by the first steps on the route towards awareness of self and others. A causal link from mind to language is indicated instead, which implies that mind can be expected to precede language in phylogenesis as well as in ontogenesis.

This expectation is borne out by studies of ape minds. It is well-established that many apes are self-aware, at least in the operational sense of passing the mirror test of Gallup (1985). Experimentally assessing the presence of a theory of mind in apes has turned out to be non-trivial, and no clear consensus has been reached, as it is very difficult to stringently rule out any possibility of non-minded processes.

Part of the lack of consensus concerns the standards of proof — evidence that would be sufficient to conclude that a child has a theory of mind, is not regarded as sufficient in the case of a chimpanzee (Griffin, 2001). This may be reasonable, as each one of us personally has first-hand evidence of a human child growing up to a being with a theory of mind, but lacks similar first-hand evidence

for non-humans, but it places a very heavy, nearly impossible, burden of proof on the proponents of ape minds. One may also consider whether lack of mind is really the appropriate null hypothesis in ape studies — *“Isn’t it far more economical to assume that if two closely related species act in a similar way, the underlying mental process is also similar? If wolves and coyotes were being compared, there would be immediate agreement about that. Why should we adopt another logic when comparing chimpanzees and humans?”* (Boesch, 2001, p 526). The situation resembles the case of ape language acquisition, where the burden of proof is similarly lopsided (see p 42).

Nevertheless, in the case of ape minds as well as ape language, the preponderance of the evidence appears to be on the side of the presence rather than absence of at least the rudiments of mind, self-awareness, and theory of mind in our nearest relatives. The acquisition of self-awareness and a theory of mind appears to be a gradual process in both ontogeny and phylogeny, with adult apes on a par with humans around the age of two. This is remarkably similar to the language skills displayed by Kanzi, who also matches a human two-year-old. This is not only evidence against any qualitative differences between humans and non-humans in either language or mind, but also evidence against there being qualitative differences between human language acquisition and other cognitive developments in human ontogeny. This is further supported by the conclusion reached on page 21, that the ape language acquisition results indicate that the postulated “language acquisition device” of humans cannot be language-specific.

There certainly remain non-trivial differences between human thought and human language, and the limited capabilities displayed by chimpanzees and dolphins and other non-humans. But as more animal studies accumulate, the differences appear more and more quantitative (however huge) rather than qualitative, and the evolutionary bridging of the gap between human language and animal communication appears far from impossible. But how to build that bridge, along the human evolutionary path, will be the topic of another thesis: (Johansson, 2002).

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