Language competence in NHPs

An assessment of the field in the light of a 'universal grammar'

"The Berlin wall is down, and so is the wall that separates man from chimpanzee."
(Elizabeth Bates)

"There is no debate, so I have no opinion."
(Noam Chomsky)

0 Introduction

The language competence of non-human primates is one of the most controversial issues in present-day linguistics, with disbelief ranging from bored indifference to vitriolic accusations of fraud. The present paper aims to assess the current state of debate from an open-minded, critical and detached perspective.

In a first part, a brief outline of earlier research in the language abilities of non-human primates - more precisely of apes (bonobos, urang-utangs, chimpanzees and gorillas) - is sketched. The second part focusses on the landmark studies published by Dr. Emily Sue Savage-Rumbaugh and her colleagues. A third section looks into the views of the Chomskyan field, leading up to the concluding section on the innateness debate.

1 Early research on non-human primates' capability for language

1.1 Attempts to teach NHPs to speak

The language capability of non-human primates has been a subject of research since the beginning of this century. In 1909 already did Witmer attempt to teach a chimpanzee to talk. He claims that the chimpanzee was capable of articulating the word 'mama'. In 1916 Furness taught an orang-utan to say the words 'papa' and 'cup'. After the unexpected death of this orang-utan, Kellogg and Kellogg wanted to follow up this work. In 1933 they obtained a young orang-utan – *Gua* – for the purpose of co-rearing it with their 9 1/2-month-old son Donald. By 12 1/2 months Gua evinced comprehension of 21 different requests while Donald, then 12 1/2 months old, was responding to 20 different requests. From that point on, Donald's comprehension began to overtake Gua's. It has to be said that the responses were always utterances which they heard frequently, were mostly action oriented and did not entail selection of a single object from a group of objects. Most of the time, they were uttered in a specific context which simplified interpretation. The last researchers to have tried to teach a non human primate to actually articulate spoken language are Hayes and Hayes in 1951. They raised *Viki,* a chimpanzee, in their home environment . After six and a half years of formal speech training – which was carefully documented – they say one was able to distinguish the words 'papa', 'mama', 'cup' and 'up'. However, they do acknowledge that these words were very poorly articulated and doubt the referential function of these words to Viki. All this research shows that the belief that man is the only animal capable of communicating in language has long been questioned. Already as early as 1661 Samuel Pepys wrote in his diary :

> I do believe it (a baboone) already understands much English ; and I am of the mind it might be taught to speak or make signs (qtd. in Wallman 1992:11)

1.2 Projects in which NHPs are taught language

After it had been proven that non-human primates are physically incapable of articulating words because the shape of their vocal tracts disables them to articulate consonants (cp. infra), researchers tried different ways of teaching language to the ape. Some have used the American Sign Language (ASL) for the deaf and others have developed an artificial language.

1.2.1 The Washoe project

The first such project was the *Washoe* project, fielded by Gardner and Gardner. Washoe, a wild-born female chimpanzee, was acquired in June 1966. At that time, she was believed to be approximately 10 months old. She lived in a trailer in the Gardners' backyard. This trailer was provided with furnishings and playthings so as to create an intellectually stimulating environment (like a child's). The researchers' aim was to teach Washoe ASL. In order to accomplish this, during her waking hours, Washoe was always accompanied by someone from the project personnel who mastered ASL. Aside from signing requests and comments, Washoe was also taught her signs through moulding and shaping. In moulding, the teacher physically guides the animal's hand into the proper configuration, location, and/or movement for the sign. Shaping is the practice of rewarding successively closer approximations to a target behaviour, here execution of a certain sign. Except for these two techniques, the researchers hoped that Washoe would also learn ASL by way of imitation. A later study has shown that shaping and imitation are not efficient in teaching ASL to apes so moulding has become the dominant pedagogical instrument. Washoe's utterances were recorded daily and by 36 months of age, she produced 85 different signs in the appropriate contextual situations and had even started to combine them as well. The Gardners' initial conclusions that signs were much more readily acquired by apes than spoken language, that moulding greatly enhanced the rate of sign acquisition and that apes generalized their signs to exemplars not utilized during training, were supported by subsequent studies. It should be noted, however, that "the anatomy and motor control of the human hand is much superior to that of the ape hand " (Savage-Rumbaugh et al. 1998:14).

1.2.2 The Sarah project

In 1973, David Premack started teaching *Sarah*, a 5-year-old chimpanzee, an artificial language. She had to answer simple questions using plastic tokens instead of words. These tokens were metal backed and could be arranged on a magnetic board. The form-meaning relationship of these tokens was completely arbitrary (e.g. a blue triangle meant "apple"). Sarah was given elaborate step-by-step training in both definitions and sequence of tokens within a statement. Her task was to arrange the symbols on a magnetic board associating particular symbols with particular meanings. A shaping procedure was developed in which Sarah was rewarded for increases in the complexity of her performance. The major critique of the Sarah-project was made by Terrace(1979a), a fellow behavioral psychologist. First of all, he claims that

> considering that almost all of her training, and testing sessions involved only a single paradigm, and that the alternatives being contrasted within a paradigm were almost always just two in number, it is quite possible that Sarah could attain her characteristic 80 percent level of correctness (Premack 1971) on a paradigm through memorization of that session's construction and the correct, that is, rewarded, response for each. (qtd. in Wallman 1992:39)

The transfer tests constitute a second point of criticism. These are intended to determine in how far the animal's experience during training has become a general capacity. Premack has put the results of all the trials of these transfer tests into a single statistic and has thus disabled a solid interpretation of the transfer tests. Since the main aim of such a test is to see whether an animal has induced an abstract, context-independent solution for a problem type, only the results of the first presentation of each new problem are of importance, since performance on subsequent trials can be confused with the effect of new learning. The possibility exists that the ape might have acquired a way to quickly apprehend which behaviour is the rewarded one.

Terrace also criticizes the claimed ability of Sarah to comprehend complex sentences such as 'Sarah banana pail apple dish insert'. He ascribes this success to the understanding of the hierarchical structure of such sentences, namely that the scope of application of "Sarah" and "insert" is the entire sentence.

To summarize the criticism one can say that Sarah has developed a skill in solving a number of problems devoid of linguistic significance. The narrow focus of each training session and the small number of alternatives might indicate that she could have memorized the correct responses. Some shortcomings of the project were that Sarah was not allowed to 'speak' spontaneously and that she only had the chips being used during each training paradigm available. Thus she could not have come to understand that her constructions with the chips or those of the trainer were communicative in nature.

1.2.3 The Lana project

The *Lana* (LANguage Analogue) project of Rumbaugh and colleagues began in 1972. The aim was to teach Lana, a two-year-old chimpanzee, a language created especially for the study. Yerkish, as the language is named, uses "a grammar of the correlational type, in which rules of sentence formation specify permissible combinations of word types, the word types being based on semantic attributes." (Wallman 1992:18) The vocabulary of this language consists of lexigrams. These are abstract symbols arrayed on a keyboard in Lana's cage. Lana has a 24-hour access to the keyboard enabling her full access to everything the computer can provide such as food and drink, show slides and a movie, provide a view out of the window, and so on. The sole condition for her to obtain these things is that Lana first composes a grammatically acceptable lexigram sequence. The keys were regularly redistributed around her keyboard so as to ensure that Lana was learning a sequence of lexigrams rather than a sequence of positions on her keyboard. Above this keyboard are two rows of each seven projectors. The first row displays the lexigram corresponding to each key Lana pushes on her keyboard. The second row shows the communications from a trainer in an adjacent room.

This computersystem has many advantages. A first one is that it poses no articulary burden on the animal. A second advantage is that the durable image of the lexigram sequence on the projectors eliminates short-term memory problems. Another positive aspect is that the use of computers prevents the tainting of Lana's linguistic performance and rules out possible cueing by the trainers(cp . Clever Hans). A last and very important advantage is the exhaustive and objective record of all linguistic transactions between Lana and the computer or Lana and her trainers.

Lana was taught to start every utterance by "please". A majority of her utterances were based on stock sentences such as " Please machine give … ". Rumbaugh also claims that she showed signs of understanding grammatical structures. She responded differently to sentence beginnings provided by her trainer. She would push the 'period' key when given an incorrect beginning of a sentence. When she was given a correct beginning, she would finish the sentence.

Just as was the case in the Sarah-project, this project also had to deal with serious criticism. A good summary is given in Wallman (1992:37):

> There is a paucity of evidence that the lexigrams in Lana's strings had separable meaning for her and substantial indication that her sequences were rotely acquired wholes, a limited number of stock-phrases developed for each of a small number of contexts, with substitution of lexigrams in variable frames, depending upon what incentives and/or trainers were present.

Further remarks are made concerning the claim that Lana would understand grammatical structures. Considering the fact that all of the keys on the keyboard have a specific colour and each colour designates a specific semantic category, the possibility exists that Lana might have cracked this colour code and thus rather than understanding syntactic structures, Lana might have memorized a chain of well-ingrained stimulus-response sequences.

Remarkable is the fact that this criticism was supported by the researchers of the project themselves. Rumbaugh and Savage-Rumbaugh have reassessed the Lana project, by way of contrasting it with their more recent work, which they feel avoids the shortcomings of the Lana project.

1.2.4 The Nim project

Another project was the one conducted by Terrace and colleagues on *Nim*. The full name of this chimpanzee is Nim Chimpsky referring to Noam Chomsky, who rejects the possibility that non-human primates might be capable of producing language. The main plan of the Nim project was to raise a chimpanzee in an environment approximating that of a child, including, especially, exposure to human language, and chart the animal's acquisition, if any, of the language. The language that was to be taught was ASL although it was in many respects a reduced form of the true sign language. That is why it is called a pidgin sign language.

Nim was two weeks old when he was first exposed to sign language, but systematic language training did not start until he was nine months old. At that time, he lived with three student research assistants. A small room was prepared for the core training which took place for five hours every weekday. This room facilitated the observation and recording of Nim's language performances, viz. the acquisition of 125 signs by the end of the project, when Nim was three years and eight months old. Although no controlled experiments on Nim's vocabulary were conducted, informal tests and his general pattern of sign use demonstrated that Nim had developed consistent associations between signs and referents.

In many respects this project was compared to the earlier conducted Washoe project. Both Washoe and Nim lived in an intellectually stimulating environment in which they were exposed to ASL. Not only the way in which the projects were conducted was similar but also the criticism that both received. The main person to criticise the Nim project was Terrace himself. After having reviewed the videotapes of Nim's signing sessions, he demonstrated that most of the multisign utterances were preceded by similar utterances on the part of his teacher. Terrace also analyzed segments of a film distributed by the Gardners and came to the conclusion that the same phenomenon existed in Washoe's behaviour. In conclusion, Terrace rejected the interpretations of Nim's productions in favor of a nonsyntactic one. However, one might say that the system effectively taught Nim to imitate.

1.2.5 Koko and Francine Patterson

Another type of research was carried out by Francine Patterson with a female gorilla called Koko. The project started out in 1972 and is still continuing today, making it the longest running study of language abilities of an ape. The project is particularly unique because of three things: firstly, it remains the only linguistic study involving a gorilla. Secondly, Koko was brought up as a bilingual; she learnt both American Sign Language and spoken English, the two were even often used simultaneously. Thirdly, Koko's linguistic achievements surpassed those of any of the other ASL apes (Table 1).

Table 1. Number of signs reported learned (for ASL apes) (Davies on Miles 1994: online)

APE	*Number of signs reported learned*
Nim	125
Washoe	133
Loulis	70
Sarah	130
Chantek	150
Koko	224
(a deaf child of three years)	132

Patterson, who was inspired by the Gardners and their 'Washoe project' (cp. supra), insists that gorillas are "peace-loving vegetarians" who have suffered from "bad press", which has, undeservedly, branded gorillas "ferocious, stubborn, and stupid" (Patterson and Linden 1981: ch.3). However, she found out that the gorilla "is less aggressive, less excitable, and in some ways a good deal easier to work with than she had anticipated"(ibid.); therefore she decided to try and teach her gorilla the use of American Sign Language (ASL). At first, the animal easily matched some chimps' vocabulary but then quickly outpaced them. At the age of three, Patterson reports, Koko signed about food most of the time. By age six, having passed infancy, Koko apparently started expressing her ideas about language and even began to call one of her female caretakers 'bird' and 'nut' in a pejorative way.

But more importantly, Koko has shown other feats which were only matched by a minority of the other non-human primates, according to Patterson. For instance, Koko quickly created new terms for unnamed objects (e.g. '*eye hat*' for mask). Consequently, Koko showed an apparent ability to rhyme (use words that would rhyme in spoken English; e.g. "*flower stink, fruit pink*") and to jest about one of her caretakers (*You dirty bad toilet).* Furthermore, she manifested an ability to lie (Hawes 1995: online reports of an instance where Koko denied eating a crayon; she signed that she was applying lipstick). Finally, the gorilla seemed to have mastered the concepts of life and death, when referring to her demised pet kitten (P: Where do you go once dead? K: *Comfortable hole bye*). Patterson also tested Koko's I.Q. and reported scores between 70 and 95 (human average being around 100).

As Patterson kept hauling up new exploits about metaphors, jokes, word games and Koko's great creativity, many of the critics portrayed Koko's abilities as "an elaborate hoax" (Tof 1996: online), not in the least because Patterson has constantly shrouded her research in secrecy. She hasn't brought out any scientific publication about her project since 1981; nevertheless, the funding for the project has continued. She even admitted to lacking substantial, empirical proof to support her claims but nonetheless rated the anecdotal material, which had been collated, very highly.

An AOL chat session, during which people could ask Koko and Patterson questions, shows why some researchers have doubts about Koko's reported abilities. The following excerpt displays heavy interpretation on behalf of Patterson.

Transcript of AOL chat-session (*Koko online transcript* 1998: online)

AOL: SickboyRE asks: Koko, have you taught other gorillas sign language, on your own?

PENNY: That's a good question. Have you taught other gorillas to sign?

KOKO: Myself lip.

PENNY: She taught herself. That's really true, too. That's very good and I think what part of that answer might be, is that she's taught us. In other words, 'myself lip' was her answer and 'lip' is her word for woman. So 'herself' has taught 'lips', perhaps. So there are a couple of interpretations there

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Even Sue Savage-Rumbaugh, whom one thinks would be in the best position to judge, found it difficult to accept reports about Koko's alleged puns, word play and knowledge of a concept like death; she said it "strained her credulity" (Savage-Rumbaugh and Lewin 1994: 46). Furthermore, she thought that Patterson "lacks the test data to rule out the impact of context-information" (o.c.:148).

Another major point of criticism was voiced by Terrace after he had evaluated a number of films of both Washoe and Koko. He concluded that both apes were as imitative as his own ape, Nim. Therefore, any evidence for grammatical patterning will be found inconclusive unless indications of imitation by the apes can be ruled out. Patterson responded by introducing blind tests, in which the subjects could not see the person giving them instructions.

Patterson's research illustrates the dichotomy that has burgeoned in the scientific community. She belongs to the camp of the researchers who treat their apes more like children and focus on the accomplishments of their subjects and the similarities between ape and human language. Patterson believes that one needs a "true rapport" (Patterson and Linden 1981: 211) with the apes in order to "bring them to the limits of their abilities" (ibid.). For Koko, this rapport meant appreciating her representational drawings, talking about her feelings, laughing at her jokes and asking how her night was; in short, treating her like a person.

The researchers in the other camp treat their apes like experimental subjects; they focus on the failures of the apes and on the differences between ape and human language.

To conclude, it is important to see the need for a happy medium and not lose track of the central question, which is not about the moral issues surrounding the non-human primate language debate. Patterson has unquestionably become very attached to Koko in the 25 years she has worked with Koko and can therefore not be counted as a valid judge to interpret her language abilities. Savage-Rumbaugh circumvented this problem by using a number of 'independent' observers (cp. infra). However, it must be said that ASL will always 'lend itself more difficult to interpret' than lexigram use and comprehension tests Savage-Rumbaugh used.

On the other hand, human language can not be used as a sole standard to measure ape language by and differences between ape and human language must not be endlessly exaggerated. Furthermore, some rapport between the caretaker and the subject is needed as a catalyst to ensure some kind of understanding (cp. Nim Chimpsky project: a possible reason for the failure is that Nim had 60 different trainers, obviously too many for a decent rapport).

1.2.6 The Primatech Project

This project differs completely from previous projects in that it does not exclusively focus on non-human primate language. The very novel aim of the Primatech project is to create an interactive simulation of a signing orang-utan.

Central in this project is Chantek, an orang-utan nearing age 22 who thinks like a 4-year old human, according to his caretakers. Lyn Miles, an anthropologist from the University of Tennessee who 'brought up' Chantek, says the orang-utan's skills resemble those of other primates like Koko. This research follows her general creed that "there is extraterrestrial intelligence – right here on earth, in the orang-utan" (Hawes 1995: online). As opposed to the education of other apes, Lyn Miles adopted a "developmental perspective that seeks to identify the cognitive and communicative processes that might underlie language development" (Miles 1990: 512).

Chantek has apparently mastered at least 150 words in ASL and has learned to clean his room, memorize the way to McDonald's, where he spends his allowance, and lie ("*He'd tell me he had to go to the bathroom and then go in there just to play with the knobs on the toilet*" Lyn Miles: online article). However, Miles insisted on calling Chantek's utterances 'Pidgin Sign English', because the "sentences are composed of signs combined in English word order but are devoid of articles and lack most of the grammatical morphemes of English" (Wallman 1992: 28). On the whole, Chantek's achievements do not differ remarkably from those in the other projects. However, he did overcome some of the errors that were found in the Nim project.

Table 2. Statistics Nim vs. Chantek(Davies on Miles 1990a: online)

	NIM	CHANTEK
imitation rate	38%	3%
spontaneity rate	4%	49-88%
interruptions of caregiver	35%	8%
interruptions of ape	~18%	9%

Like Francine Patterson with Koko (cp. supra), Lyn Miles reported a number of amazing achievements for Chantek. The orang-utan too can create novel words (e.g. '*eye drink'* for contact lens solution) and lie (Miles calculated that Chantek lied an average of three times a week). Furthermore, Chantek seemed to have invented some of his own grammatical rules; he would always place an action in front of a visible object (e.g. *'play ball*') and put an invisible object in front of an action (e.g. *'ball, play*).

Miles's strongest claims were about reference. Comparing Chantek's development to that of a human child, she found evidence that Chantek was using words and signs referentially. Like human children, Chantek showed different stages in his referential communication; he went from pointing to an object, to "labelling and semantic overgeneralization or undergeneralization" (Miles 1990:524) and ended up with representational naming.

As orang-utans mostly live a solitary life in the wild, the education of an orang-utan partly rescinded earlier scientific claims that a primate's perceived language ability rests on his need for social interactions with other individuals. Offering another account for the language ability, Miles called on other, general cognitive capabilities of apes as underlying their apparent capacity to learn human language. First of all, primates seem to be able to "remember over the course of several years the location of various reliable fruiting trees within a vast territory" (Hawes 1995: online). Subsequently, primates show a remarkable expertise with tools (Chantek used 22 tools in a sequence once).

However, Miles says the 'social living theory' must not totally be written off; orang-utans may well have been more 'social' previously and were driven to a more solitary way of life due to environmental degradation. Human disturbance brought along a move to new habitats, where food was scarcer, thus increasing the competition within the groups.

Where previous projects concentrated on the ape and his ability to both sign and understand signing, the Primatech Project incorporates the ape's abilities in a larger frame. Jim Davies, from the college of computing at Georgia Tech, who is co-ordinating the project, says the aim of Primatech is to "create an installation that simulates communicating with an orang-utan" (Davies 1999: online). Davies acknowledges that ape language research is a controversial subject and suggests that the best approach to modelling ape language is to "rely on basic cognition before introducing higher-level language structures" (Davies, Primatech Abstract 1999: online).

If all goes well, members of the public will ultimately be able to communicate with a virtual orang-utan, whose movements, signing, and language abilities are modelled on those of Chantek. Figure 1 schematizes these processes.

Figure 1. Schematic representation of the Primatech project

The research will cover three domains. Firstly, *Animation* will be of great importance for the virtual orang-utan. Based on a 3D model of Chantek, the graphical model will move in predefined ways, which correspond to actual orang-utan anatomy. Existing theories of animal behaviour will also figure prominently in the shaping of the graphical model.

Secondly, *Intelligence*, and, more specifically, artificial intelligence will be used to both recognise and generate language like a non-human primate would. Especially this computational modelling of primate language use is state of the art in primate language research and will certainly shed a new light on the issue.

A third important aspect of the Primatech Project is voice and sign language recognition. Once again, the installation will be modelled on Chantek in that it will recognise a subset of spoken English and ASL. On a first level, utterances will be recorded by both a camera and a microphone; then they will be analysed by a recognizer which will send them to the intelligence module (cp. supra). The system should be able to handle a number of different grammars and vocabularies.

In the end, the simulation will be placed in the Atlanta Zoo, where visitors will be able to communicate with the virtual orang-utan.

1.2.7 The Sherman and Austin project

So far, none of the projects have dealt with the question whether the signs or keys that are used by the apes have a referential function to them. The focus has been on the capacity to master a certain degree of syntax. What makes the Sherman and Austin project so important is its investigation of the cognitive competencies that underlie symbolic processes.

The Sherman and Austin project started in 1975, at which time Sherman was two and a half and Austin was one and a half years old. This study was performed by Savage-Rumbaugh and Rumbaugh. They were interested in the animals' ability to comprehend and to communicate, they wanted Sherman and Austin, two chimpanzees, to use symbols referentially. The medium to do so was a modified version of the computerized keyboard used in the Lana project. Symbols that represent objects or activities are arbitrary geometric forms based on the Yerkish language. The keyboard eventually grew to 92 symbols. So as to prevent that the chimps would learn keyboard positions, the keys were randomly rearranged after every keyboard use. Another medium used to get the chimps to do something was speech. After much research on how to teach a chimp vocabulary, they used the 'request task', meaning "I show you X, you select the lexigram that goes with X, and then I give you X". In this case, the ape selects the symbol or makes the sign on the basis of what it anticipates will happen afterward. From these experiences flowed a means of communicating wishes, which Sherman and Austin unexpectedly learned on their own. The ability to request is just one of three major abilities in communication. The other two are (i) the ability to name objects and (ii) a comprehension of symbols as referring to objects. In order to teach the chimps the naming of objects without receiving them afterwards, a technique called 'fading' was applied. This refers to the fact that the size of the food item given to the chimp gradually diminishes, while the size of the item he is being shown does not change.

> For example, if the food we wanted them to name was "sweet potato", we gave them a smaller and smaller piece of sweet potato each time they did so, along with a large piece of some other food, to indicate we were still pleased. (Savage-Rumbaugh and Lewin 1994:68-69)

After having learned this for three food items, tests were held to see whether they could generalize the concept to the other symbols in their vocabulary. They did so easily. By having learned this, Sherman and Austin had learned to make a distinction between communication for its own ends and communication about the properties of the units of the system. The next step was to teach them receptive skills, comprehension. To do so, the trainer went into their room with a container with food in it. The chimps knew that when she entered with food in her hands, they were allowed to ask for the food with their keyboard. Since they did not know the content of the container, they had to listen to the trainer in order to find out what was in it. After the trainer had told them what was in it, they went to their keyboards and asked for the food. This shows that they had been listening to what the trainer was saying. The next step is to make them tell each other what is in the container. One of the chimps (the informer) was allowed to see what was being put inside the container. When he came back in his room, he pushed the correct key thus informing the other chimp of the contents of the container. Only if both had correctly requested the food in the container were the contents of the container shared. Through this procedure Sherman and Austin had learned both interindividual communication and cooperation. Thus, they even learned to share their food which is highly unusual for chimpanzees. With surprising ease, Sherman and Austin learned to attend to each other, attend to the requests made, and proffer the specified food. The experiment was taken one step further : the food was hidden in sites in their room. In order to obtain the food, the chimp needed one of six tools (key, money, stick, straw, sponge, and wrench). The chimpanzees were put into two rooms separated from each other by a window. One chimp would have access to the tools while the other would be in the room where food was put in a site. They immediately understood how to obtain the food. The one in the room containing food would use his keyboard to tell the other which tool he needed. The tool-supplier would then give the appropriate tool and in the end they shared the obtained food. This experiment proves that the chimps not only comprehend but also show intentionality.

Although these results were extremely pertinent to the ape-language debate, little attention was paid to them since the supposed primacy of syntax still held most researchers in its thrall. The little response that was received was from the behaviorist camp that claimed that these experiments could be compared to previous experiments with pigeons. Savage-Rumbaugh and Rumbaugh replied to this assault by saying that Sherman and Austin were exhibiting conscious intentionality during their communication. To prove this, it was important to demonstrate beyond reasonable doubt not only that Sherman and Austin could communicate with each other, but also that they indeed knew that they were communicating. To do so, another experiment was set up in which one of the chimps would see what food was put in a container, was then brought back to his room where the keyboard had been turned off and had to try and tell the other which food was in the container with the help of food labels that were scattered on the floor. The chimps had seen the food labels before when being around the refrigerator. This experiment entailed many presuppositions: would they feel the need to tell the other what was in the container when the keyboard was turned off? would they recognise the label? and would they think of using the labels as a means of communication? But surprisingly, Sherman and Austin had no difficulties with the situation. The test was continued with 30 different food labels all of which were correctly recognised by Sherman and Austin. Another experiment that was carried out was to introduce the idea of generic symbols. This experiment was split up into three stages: first, they were taught the categories 'food' and 'tool' after which they were shown food items and tools that had not been part of the training regime. Then the same process was repeated with plastic-covered photographs of food items and tools. Finally, they were shown symbols for food items and tools. This third part of the experiment was crucial in that it could prove the representational value of Sherman and Austin's symbols. The results of the tests were very positive; both chimps scored successes on all three tasks.

In conclusion,

> Sherman and Austin did not merely imitate their teachers : they were economic and informative with their symbol production; they did take turns in communication, both with each other and with their teachers; and finally, although much of their symbol product was request oriented, they moved beyond this sage to spontaneous symbol production either to announce or comment on their action. (Savage-Rumbaugh and Lewin 1994:91)

2 Kanzi and beyond

2.1 Introduction

Even though the Washoe project yielded interesting results and received ample public attention, the Gardners were unable to refute Terrace's claims. Rather, they replicated their work with other chimpanzee subjects, but again they failed to address the crucial issues, those of imitation and inadvertent cueing by researchers (Savage-Rumbaugh et al. 1993:8). The report of Fouts et al. (1989) of signing between apes without humans present, failed to show that "these gestures differed in function from the many nonverbal gestures and 'body language' that the chimpanzees employ as well" (Savage-Rumbaugh et al. 1993:8). After the ground-breaking work with Sherman and Austin, reported above, it was finally the work with Kanzi that provided a major break-through in ape language research, as this research would also reveal syntactic competence in addition to (decontextualized) symbol comprehension.

2.2 Introducing Kanzi

The bonobo (*Pan Paniscus*) Kanzi was born in 1980 and he picked up language by observing his mother's language training. Kanzi was not taught the use of lexigrams actively, but appeared to have mastered their use on his own, even though he had never seemed to be particularly interested in his mother's language course. Indeed, at two and a half years of age, he correctly employed nearly all of the ten lexigrams that were on his mother's keyboard at that time, and what is more, he also understood the spoken English words which the lexigrams represented (*Kanzi* 1998: online). Whereas Sherman and Austin *seemed* to understand spoken language, carefully controlled tests showed that true speech comprehension was lacking (ibid.). Kanzi, however, is truly capable of symbol-to-symbol transfer: he can listen to a word and select the written or printed symbol for it. But Kanzi can do more than that, as the subsequent paragraphs will demonstrate.

2.3 Kanzi's comprehensive abilities compared to those of a human child

2.3.1 Basic tenets

A detailed study of Kanzi's comprehensive competence, in comparison to that of a human child named Alia, is offered in Savage-Rumbaugh et al. 1993. In accordance with recent findings in research on child language, it is one of the authors' basic tenets that comprehension precedes production when language is not trained but acquired naturally through observation (cp. infra). After all, in basic language production all that is required is the 'wording' of the speaker's own ideas or mental states, whereas even the most elementary comprehension precludes foreknowledge: the other's intentions cannot be known to the hearer. As both these data, and data from child language research (as summarized in Savage-Rumbaugh et. al. 1993:16-23), have shown, comprehension abilities emerge earlier and rise to more impressive levels earlier than productive skills. As Savage-Rumbaugh et al. note:

> Children do not learn language by talking; they learn it by listening. (o.c.:24)

When training emphasizes comprehension, production will occur as a "spontaneous by-product" of such training (o.c.:19). Comprehension does not require reinforcement: an infant will naturally strive to "understand" in order to "predict what the speaker is going to do as a consequence of having produced a particular utterance" (ibid.).

Another basic tenet of this (and subsequent) research by the team led by Dr. Sue Savage-Rumbaugh is that reward-based rote learning has to be abandoned. The failure of Matata, Kanzi's mother, to learn the use of lexigrams with any amount of ease, and the subsequent success of Kanzi himself, have convincingly shown that, as with children, NHPs do not need special training to acquire language. The only condition for observational learning is that they are exposed to language ("immersion") from an early age. Indeed, for NHPs as for children, there appears to be a "critical period" for language, due to the higher brain plasticity of infants. It would seem that brains of language-competent NHPs outweigh those of nonlanguage-competent ones (Savage-Rumbaugh et al. 1998:213).

2.3.2 Reference: learning how to mean

It remains to a large extent a mystery - often referred to as Quine's dilemma - how infants determine where words begin and end, and how they "come to understand that words refer to particular objects, events, emotions, etc." (o.c.:13), irrespective of the presence or absence of these objects (cp. "Kanzi, don't bite the ball", "Where's your ball?", "He's having a ball", ibid.). A "process-oriented perspective of reference" (o.c.:15) is proposed, in which the use of words is seen as an attempt to "bring about a certain behavior or set of beliefs in the listener" (o.c.:14), based on previous perceived utterances of a word and the various events surrounding its previous use.

Rather than learning words to NHPs through associative training in "naming", a successful approach is that of interindividual routines. When an ape learns to name a "banana", it will not be able to respond appropriately to messages regarding the state, absence, location, etc. of the bananas (o.c.:15). Indeed, it is precisely the *decontextualized* use of symbols that points at true comprehension:

> It is easy to train an ape to say *apple* in order to get an apple but difficult to teach it to use *apple* to describe a food that it is not allowed to eat, a food that it sees someone else eating, a food that it does not like, a food that is in a particular location, etc. (ibid.)

Once the stage of decontextualization has been reached, infants are able to assign a new word to a new referent.

As already noted in passing, the language acquisition model based on observational learning describes infants' symbol acquisition in terms of the learning of interindividual routines, as observed by Savage-Rumbaugh et al. (1993) in four apes and two human children.

The term *interindividual routine* is defined as a "more or less regularly sequenced set of interindividual interactions that occur in a relatively similar manner on different occasions" (o.c.:25). Apart from verbal markers, postural and gestural markers are equally important in engaging in such an interaction. As is observed regularly in publications by Savage-Rumbaugh and her team, such additional markers are important to signal the *intentionality* of the communication taking place. Once a routine (such as 'changing diapers' or 'playing with bubbles') and its markers - verbal and others - are understood, the infant can manipulate the course of events by using these markers to initiate the routine. (Note again how comprehension precedes production.) These initiations grow gradually less context-dependent: instead of picking up the bottle of bubbles, for instance, infants will say "bubbles" or point to the "bubbles" lexigram, thus assuming the role of a "symbolic communicator capable of announcing their intentions to another party" (o.c.:30). The ultimate driving force behind language acquisition, according to this model, is then

> not the caretaker; rather, it is the desire of the child or ape accurately to predict what is going to happen to him or her next that motivates the attention toward the acquisition of vocal and gestural markers. (o.c.:32)

The knowledge of specific referents comes "from a group of intermeshed routines that have overlapping markers" (o.c.:33): from routines such as "playing with the bubbles", "helping find the bubbles", "putting the bubbles in the bath water" and "hide the bubbles", it appears that the item common to all these routines is called "(bottle of) bubbles".

2.3.3 Methodology of the comparative study in Savage-Rumbaugh et al. 1993

The rearing histories of Kanzi and Alia were very similar. They were both exposed to both spoken English and lexigrams from infancy, but they were not "trained" to talk. They shared a prime caregiver, Jeannine Murphy, who spent forenoons with Kanzi and afternoons with her daughter Alia, in a mobile home with approximately the same indoor environment. Both subjects were separated from the experimenter by a mirror during the tests.

During a number of nonblind trials, the subjects were "accustomed to responding to requests produced by a disembodied voice" (o.c.:50). The blind trials started after 244 trials for Kanzi, and 180 for Alia. "For purposes of data analysis, only trials subsequent to the 244th are treated as 'blind' trials for both subjects." (o.c.:51) In the trials, the subjects were asked to perform one or other action. This required them to understand novel, and often very unusual, sentences and to act accordingly, without any further contextual cues. During these tests, several objects were in front of the subjects, so they had to select the correct one to perform an action on it (table 3). Moreover, several sentences were given for each array of objects:

> For example, the sentences "Go vacuum Liz," " Go put some soap on Liz," "Rose is gonna chase Kanzi," "Put on the monster mask and scare Linda," "I want Kanzi to grab Rose," "Take the mushrooms to Matata," and "Kanzi is going to chase Rose" were all presented while the array in front of Kanzi consisted of the following items: monster mask, ball, bunny puppet, sweet potato, melon, soap, umbrella, straw, toothbrush, toy gorilla, hose, vacuum, mushrooms, two televisions, and a shoe. The persons in the room were Liz, Linda, Rose, and Kelly, and the available locations were tool room, colony room, microwave, refrigerator, outdoors, and potty. (o.c. 53)

Table 3. Mean number of objects and agents in the arrays facing Kanzi and Alia

(Savage-Rumbaugh et al. 1993:51)

	KANZI		ALIA	
TRIALS	Objects	Agents	Objects	Agents
1-100	18	3	5	2
101-200	13	2	4	2
201-300	7	3	6	2
301-400	8	3	7	3
401-500	9	3	7	3
501-600	12	3	8	3
601-end	12	3	8	3

As mentioned earlier, the sentences were also quite unusual. Kanzi and Alia were familiar with "dogs" and "snakes" as real animals, whereas in these tests, they referred to toy animals, and (toy) snakes appear to be able to bite (toy) dogs. Similarly, neither subject could know from previous experience what sentences such as "Take the lettuce out of the microwave" or "Wash the hotdogs" mean, as lettuce is not normally kept in microwaves, and hotdogs are not normally washed (o.c. 53).

The subjects were confronted with 660 different sentences, for which the entire test environment was recorded (cp. previous block quote). For the blind trials, extra information was also taken down. Moreover, all tests were videotaped.

The sentences were divided into 7 main types with a number of subtypes, yielding 13 types in total:

Table 4. Sentence types (Savage-Rumbaugh et al. 1993:54-67)

Type	Description	Example
1A	Put object X in/on transportable object Y	Put the ball on the pine needles
1B	Put object X in nontransportable object Y	Put the ice water in the potty
2A	Give (or show) object X to animate A	Give the lighter to Rose
2B	Give object X and object Y to animate A	Give the peas and the sweet potatoes to Kelly
2C	(Do) action A on animate A	Give Rose a hug
2D	(Do) action A on animate A with object X	Get Rose with the snake
3	(Do) action A on object X (with object Y)	Knife the sweet potatoe
4	Announce information	The surprise is hiding in the dishwasher
5A	Take object X to location Y	Take the snake outdoors
5B	Go to location Y and get object X	Go to the refrigerator and get a banana
5C	Go get object X that's in location Y	Go get the carrot that's in the microwave.
6	Make pretend animate A do action A on recipient Y	Make the doggie bite the snake
7	All other sentences	Take the potato outdoors and get the apple

Some clarifications are in order. The difference between 1A and 1B was introduced because requests involving a nontransportable object are presumably simpler, as such an object cannot be moved. Hence, in sentence type 1B, inversal of the object-object relation is precluded, whereas in 1A, it might occur.

In sentence types 2A-2D, the 'animates' are persons or toy animals. It is the subjects who transferred the terms from the real animals to the inanimate representations of them. 2B serves to demonstrate that the subjects do not simply perform a random action involving object X and Y (the 'key words'), but indeed understand the relation implied in the verb. A number of different verbs was used in type 2C (bite, chase, groom, hammer, hide, hug, play, scare, slap, tickle, wash, vacuum) and 2D (brush, feed, get, hide, hit, put, scare, take, tickle, throw, wash). The added complexity of type 2D requires the subject to grasp the syntax of the complete sentence, as the object-recipient relation is not inherent in its semantics. For example, "Hit the dog with the stick" could result either in hitting the stick with the (toy) dog, or in hitting the dog with the stick.

Similarly, requests of sentence type 3 cannot be executed correctly simply by responding to key words: the sweet potato of the example in table 4 could act on the knife just as well. A basic syntactic understanding is again required.

The sentences of type 4 were not included to investigate syntactic features, as they simply provide the subject with information (viz. where an object was hidden, or that another party was about to engage in a game with the subject). This sentence type was included so as to determine whether the subjects could make the correct inferences from a statement (or 'non-request').

Sentence type 5A is roughly synonymous to type 1B, but distinct spatial entities are used as 'locations', rather than objects as 'recipients'. For sentence type 5B, between six and nine different words indicating locations were employed during each session, and three or more objects were placed in each of these locations, so that the subject had to remember which object to retrieve. Moreover, these objects were not usually found at that place. In a control set of sentences, "the item to be retrieved from the distal location was duplicated in the central array" (o.c.:64). However, errors in carrying out these requests could be due to the semantic ambiguity inherent in 5B: "the subject could interpret the sentence as a request to go to a location, then return and "get" the object in the central array" (o.c.:64-65). Type 5C sentences preclude this possibility by using an embedded phrasal modifier, thus introducing an element of recursion in the sentence structure.

Initially, the responses received one of three codes: correct, partially correct or incorrect - by Sue Savage-Rumbaugh for Kanzi, and by Jeannine Murphy for Alia. A third person scored both subjects' responses on videotape. A fourth observer coded 326 randomly selected trials from videotape of Alia. Statistical calculations were made to assess judgement agreement:

> Percentage agreement on the judgment of correct, partially correct, or incorrect response was .98 for Kanzi and .89 for Alia. Percentage agreement on judgments that behaviors on the part of the experimenter may have helped the subject was .83 for Kanzi and .64 for Alia. (o.c.:71)

Subsequently, Sue Savage-Rumbaugh reviewed the tapes to see what led to discrepancies in judgements. This review revealed that Savage-Rumbaugh and Murphy made inferences "as to whether Kanzi and Alia were cooperating, attending, purposefully ignoring them, etc." (ibid.). Indeed, it is important to take this 'intimate' knowledge of the researcher working with a subject most of the time, into account. Hence, the coding system was substantially extended, as represented in table 5. More statistical analysis determined coding agreement at .72 for Kanzi and .83 for Alia. On top of that, 38 randomly selected requests were presented twice (with week- or month-long intervals) to Kanzi so as to provide a measure of validity. On 79% of these second-presentation trials, Kanzi did as well or better. The test-retest reliability was not expected from Alia, due to her rapid development.

Table 5. Criteria for coding subjects' responses to requests (Savage-Rumbaugh et al. 1993:73)

Code and type of response			*Response*
Correct:			
	C		S carries out the request immediately and correctly
	C1-C5		S first hesitates or engages in a tangential activity, then ...
		C1	S carries out the request correctly
		C2	E repeats the request; S carries it out promptly
		C3	E rewords and may repeat the request; S carries it out promptly
		C4	S's involvement in the tangential activity interferes with his/her ability to attend; E insists the activity stop and then repeats the request; S carries it out promptly
		C5	Asked to retrieve a distal object, S attends to its duplicate in the immediate array; E redirects attention to the distal object; S retrieves it promptly
Partially correct:			
	PC		S is partially correct in carrying out the request
	OE		S retrieves more objects than requested
	I		S carries out the act in inverse order but is correct with regard to all other components of the request
Incorrect:			
	W		S is incorrect with regard to all aspects of the request
	NR		S does not respond or refuses to respond
	M		Mistrial (an item mentioned in the request was unavailable)
Note: S= Subject; E= Experimenter.			

2.3.4 Results

The results are quite impressive: Kanzi was correct on 72 % of all trials, and 74 % of the blind ones, and Alia on 66 and 65 % respectively. The overall scores are given in table 6; table 7 lists the results per sentence type. (In table 7, only the 'correct' codes are included in the 'percentage correct', hence, both partially correct and incorrect responses were counted as errors. Many of the partially correct responses showed an understanding of the sentence structure, but not of all the words, as the subjects performed the correct activity with the incorrect object; o.c. 80.)

Table 6. Proportions of different response codes obtained by Kanzi and Alia (Savage-Rumbaugh et al. 1993:77)

	KANZI				*ALIA*			
	All trials		*Blind trials*		*All trials*		*Blind trials*	
Response	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
C	369	57	246	59	319	54	220	54
C1	11	2	10	2	20	3	18	4
C2	36	6	16	4	32	6	16	4
C3	34	5	21	5	13	2	9	2
C4	8	1	7	2	7	1	4	1
C5	9	1	7	2	0	0	0	0
Total correct	467	72	307	74	391	66	267	65
PC	153	23	87	21	124	21	84	21
OE	6	1	5	1	20	3	17	4
I	9	1	8	2	9	2	7	2
W	8	1	4	1	32	6	24	6
NR	10	2	4	1	11	2	8	2
Total wrong	186	28	108	26	196	34	140	35
Overall total	653	100	415	100	587	100	407	100

Table 7. Proportion of responses to different sentence types coded correct for Kanzi and Alia(Savage-Rumbaugh et al. 1993:78)

	KANZI			*ALIA*		
Sentence type	*Count*	*% Correct*	*Adjusted res.*	*Count*	*% Correct*	*Adjusted res.*
All trials:						
1A	80/126	64	-1.4	88/123	72	1.4
1B	36/49	74	.1	31/43	72	-.1
2A	56/69	81	.0	47/58	81	-.0
2B	7/21	33	-1.6	12/21	57	1.6
2C	16/18	89	.2	13/15	87	-.2
2D	61/86	71	1.5	45/75	60	-1.5

3	56/80	70	.6	41/63	65	-.6
4	10/16	63	-1.3	11/13	85	1.3
5A	64/85	75	.9	55/80	69	-.9
5B	40/47	85	3.5	23/45	51	-3.5
5C	27/35	77	2.2	16/31	52	-2.2
6	7/10	70	.5	6/10	60	-.5
7	7/11	64	1.5	3/10	30	-1.5
Blind trials only:						
1A	39/62	63	-1.3	47/64	73	1.3
1B	13/17	77	.4	12/17	71	-.4
2A	36/46	78	-.7	36/43	84	.7
2B	7/19	37	-1.3	12/21	57	1.3
2C	10/11	91	.0	10/11	91	.0
2D	37/49	76	1.6	31/51	61	-1.6
3	40/49	82	2.0	25/40	63	-2.0
4	8/12	67	-.9	10/12	83	.9
5A	45/58	78	.8	42/59	71	-.8
5B	32/39	82	3.4	18/40	45	-3.4
5C	27/35	77	2.2	16/31	52	-2.2
6	6/9	67	.5	5/9	56	-.5
7	7/9	78	1.9	3/9	33	-1.9
Note: adjusted res.= adjusted residuals (indication of better performance compared to the other subject; the numbers for Kanzi and Alia are the same, but the + or - sign is the opposite each time)						

The mere statistical probability that the simple object-location sentences would be responded to correctly, is calculated to be 2.4 %, and for other sentence types, it would be even less (o.c. 76). We may safely conclude that true comprehension was ascertained in both subjects. Let us consider the results of some of the sentence types in more detail.

Type 1A and B elicited a large number of correct responses from both subjects, and Kanzi performed 10 % better on type 1B requests, in which the two objects are not readily reversible due to the non-transportable nature of one of them (although some "non-transportable" objects proved to be quite transportable once Kanzi decided to move them…). Type 2B appeared to be very difficult for both, but significantly more difficult for Kanzi than for Alia, as it required the subjects to memorize two unrelated objects and perform the same action on both. "Kanzi's difficulty was perhaps due more to short-term memory limitations on the overall amount of information than to processing limitations on the information available to him" (o.c. 85). One must after all bear in mind that a human brain is considerably larger than an ape's… Indeed, Kanzi performed better on a sentence such as "Feed the dog some milk", in which the information can be chunked meaningfully, than on a type 2B request such as "Show me the milk and the dog".

Some of the errors on type 2D and 3 requests were not due to comprehension errors: for type 2D, a hesitancy of the subject to act directly on another person with an object prompted errors, and for type 3, the decidedly odd nature of requests (e.g. "Bite the picture of the oil", o.c. 86) may have caused some errors.

Kanzi's performance on type 5B and 5C requests was significantly better than Alia's. As noted earlier, type 5B sentences were ambiguous, whereas in 5C sentences, the ambiguity was resolved by using a phrasal modifier ("Go get object Y that's in location X"). Indeed, the subjects performed far better on control trials - in which the item to be retrieved was present both in the immediate array and in the distal location - for 5C than for 5B: Kanzi, for example, acted on the object in the near array on only 9 % of these control trials, as contrasted with 50 % of the type 5B control trials. Similar observations hold for Alia (o.c. 89-90). The understanding of a phrasal modifier clarifying the object of reference indicates that both subjects could interpret the syntactic device of recursion.

The research team led by Dr. Savage-Rumbaugh regrouped the obtained data into three groups in order to see whether the subjects comprehended reversal of word order: (A) verb plus word order changes, and appropriate response differs (e.g. "Could you take the pine needles outdoors?"/"Go outdoors and get the pine needles"), (B) word order remains constant, but appropriate response differs ("Take the rock outdoors"/"Go get the rock that's outdoors") and (C) word order changes, and appropriate response changes ("Put the juice in the egg"/"Put the egg in the juice") (o.c. 92). Results are listed in table 8, indicating that these sentences were a difficult challenge to both, and that Kanzi performed significantly better than Alia, who tended to return from various locations with more than one object.

Table 8. Comparison of Kanzi and Alia's performance on reversed sentences over three subtypes of reversals: summary statistics (Savage-Rumbaugh et al. 1993:92)

		KANZI		*ALIA*	
		C/N	*%*	*C/N*	*%*
Subtype A					
	Sentences	38/46	83	26/44	59
	Pairs	17/23	74	8/21	38
Subtype B					
	Sentences	22/28	79	18/27	67
	Pairs	8/14	57	5/13	38
Subtype C					
	Sentences	33/42	79	27/39	69
	Pairs	12/21	57	7/18	39
C = number of correct responses (C, C1-5 in table 3); N = total number of sentences or sentence pairs given to the subject					

It is important to note that real inversion errors were scarce: semantic errors predominated (e.g. putting the melon in the water when requested to "put the melon in the tomatoes", o.c. 96). Indeed, both subjects' overall performance indicates that they were "sensitive to word order as well as to the semantic and syntactic cues that signaled when to ignore word order [e.g. "Go get the carrot that's outdoors"] and when to attend to it [e.g. "Make the doggie bite the snake"]" (o.c. 97).

In conclusion, it should be clear by now that both Kanzi and Alia were able to understand the semantics and the syntactic structure of unusual English sentences, even though neither of them was as yet a fluent speaker.

> The lack of contingent reward, the novel nature of the requests, the absence of previous training to perform these specific requests, and the unique nature of each trial countermand simple explanations that depend on the conditioning of responses independently of semantic and syntactic comprehension. Both subjects clearly demonstrated a capacity to process the semantic and syntactic information in the sentences presented to them. Moreover, the manner in which they did so revealed that they did not interpret the words contained in sentences as randomly juxtaposed events, to be acted on independently. Instead, they invariably attempted to carry out a complex set of related actions that reflected their interpretation of the semantic and syntactic features of each novel utterance. Thus, for example, Kanzi's solution to "Put the water on the carrot" was to toss it out into the rain. Such innovative actions revealed a sophisticated processing of the speaker's intent (in this case, to get the carrot wet) rather than a rote, unthinking solution. Even when the subjects failed, they virtually never did so in a way that would suggest that they were assigning key words randomly. (o.c. 98-99)

In addition, it should be noted that this study was carried out with an amazing sense for detail and precision, as shown in the elaborate coding system applied by various coders, the statistical analyses applied to the data at various stages, the recurrent methodological reflections, and the very detailed information provided in the appendix (o.c. 111-210).

2.4 The importance of a language-rich environment

In order to demonstrate once more that the good results obtained with Kanzi and with another language-competent bonobo, Panbanisha, are not due to subtle cues provided by the context, Panbanisha's results were confronted with those for another bonobo, Tamuli, who was only exposed to a 'language-rich' environment at 3.5 years of age. The sentence constructions under consideration employed A(ctions), O(bjects), R(ecipients) and L(ocations) in the combinations AO, AL, ARO, AOR, AOL, yielding a total of 145 sentences (examples: table 9). As in the previous study, many alternatives were available in the context. The results are listed in table 10.

Table 9. Examples of sentence types (Williams et al. 1997:308-311)

type	example
Action-Object (AO)	Hammer the soap
Action-Location (AL)	Go to the potty
Action-Recipient-Object (ARO)	Let's give doggies a rock
Action-Object-Recipient (AOR)	Take the hot dog to Tamuli
Action-Object-Location (AOL)	Put the straw in the ball

Table 10. Summary of sentence comprehension data for Panbanisha and Tamuli (Williams et al. 1997:307)

	PANBANISHA		*TAMULI*		*KANZI*	
Sentence type	*(#C/F)*	*%*	*(#C/F)*	*%*	*(#C/F)*	*%*
Action-object	45/50	90	5/50	10	105/107	98
Action-location	9/12	75	2/12	17	23/23	100
Subtotal	54/62	87	7/62	11	128/130	98
Action-recipient-object	19/24	79	1/24	04	3/04	75
Action-object-recipient	6/07	86	0/07	00	17/19	89
Action-object-location	25/42	60	1/42	02	33/36	92
Subtotal	50/73	68	2/73	03	53/59	90
Other	8/10	80	0/10	00	65/74	88
Grand total	112/145	77	9/145	06	246/263	94

Number correct (#C), frequency (F), percentage correct (%). Kanzi's data is from Savage-Rumbaugh 1987.

Whereas "Tamuli does possess the communicative skills necessary to function successfully in the ape world" (o.c.:313), it appears from these data that Tamuli's comprehension of spoken English and lexigrams is nearly non-existent: she responded correctly on 6% of the sentences, as contrasted to Panbanisha's score of 77 %. Moreover, Panbanisha was never completely incorrect; whereas Tamuli was given an 'incorrect' score on 63% of her responses. She also refused to respond more often than did Panbanisha (15 times as opposed to twice). Her overall score of 6 % cannot readily be accounted for by single word comprehension, as appeared from an additional test. Rather, contextual information of some kind may have helped her to respond appropriately, and even chance circumstances served to elicit a correct response:

> When asked to 'Find the book', Tamuli ran to look out the window and picked up a book lying in her path. Two other sentences to which Tamuli responded appropriately involved a plastic bag, an object which she found highly attractive and which she often incorporated in her incorrect responses as well. (o.c.:309-311)

2.5 Kanzi's grammar

Let us go on to consider more specifically the issue of *grammar*. Greenfield and Savage-Rumbaugh (1990) define grammar as "a set of formal rules for marking relations between categories of semiotic elements" (o.c. 541). The comprehension of various syntactic construals by Kanzi has already been demonstrated in our discussion of Savage-Rumbaugh et al. (1993). In order to ascertain to what extent Kanzi also uses (and in fact, partly invents) a (proto)grammar in his production of lexigram-lexigram and lexigram-gesture combinations, Greenfield and Savage-Rumbaugh (1990:541) adopt five criteria (table 11), and show how these are all met by Kanzi's performance (o.c. 553ff.). From the onset, it is stressed that evidence of "the *invention* of grammatical rules by apes would be stronger evidence of evolutionary continuity than merely learning of rules" (o.c. 543). Indeed, early protohumans did not have any models to rely on: at one or other stage, language as we know it was "invented".

Table 11. Five criteria necessary for a grammatical rule (Greenfield and Savage-Rumbaugh 1990:541, cp. Savage-Rumbaugh and Lewin 1994:158-159)

1	Each component of a combination must have independent symbolic status.
2	The relationship between symbols must be reliable and meaningful (semantic).
3	A rule must specify relations between *categories* of symbols across combinations, not merely a relation between individual symbols.
4	Some formal device, such as statistically reliable order, must be used to relate symbol categories across combinations.
5	The rule must be productive: a wide variety of spontaneous combinations must be generated.

The corpus resulting from five months of observation yielded 1,422 combinations of two or more elements (out of 13,691 utterances, or 10.39 %, o.c. 550). Half of this material was disregarded, mainly because there was no second observer present to record the context for these tokens. (Apart from that, partial or complete imitations - 2.67 % of total combinations - and utterances that were solicited in any way were not included in the final corpus.) The resulting 723 two-symbol utterances nevertheless constitute a much larger corpus than the usual child language corpus for a similar stage of development (o.c. 551). Lexigrams clearly are no icons - they do not bear any resemblance to their referent - and they can transcend indexical usage to function as a true 'symbol' (in Peirce's terminology, o.c. 552ff.). Gestures on the other hand, often are iconic and/or indexical. This does not invalidate their status as semiotic elements, however: human grammar uses a number of indexical signs as well (e.g. demonstrative pronouns), and interestingly, pointing gestures are also important signs for deaf children of hearing parents (which, like Kanzi, lack a pre-established model of language). Apart from 'demonstrative gestures', Kanzi used clearly distinct gestures for "go", "come", "bite", "tickle", "chase", "yes", "open", and "bad" (o.c.564n). In addition, it should be noted that the lexigram system does not offer the possibility of morphological inflection, so Kanzi's grammar can only be expected to use word order as a formal device.

The two-symbol combinations were analyzed in terms of semantic roles similar to those used in child language studies. Seven out of the eight major relations in children's utterances at the two-word stage were found in Kanzi's data, viz. agent-action, action-object, agent-object, entity-demonstrative, goal-action, location-entity and entity-attribute. Possession is the 'missing' relation; conjoined action (e.g. 'tickle bite', cp. English 'go get') was missing in children's utterances.

In general, it appears that the first criterion is met: individual lexigrams were only regarded as distinct semiotic elements if they occurred spontaneously on 9 of 10 occasions and if Kanzi "demonstrated behavioral concordance on 9 of 10 of the subsequent occasions" (o.c. 553). The relation between symbols was clearly reliable (criterion 2): Kanzi "rarely paraphrased or repeated himself or formed combinations that were semantically unrelated" (o.c. 556): only 6 out of 723 utterances showed no 'direct relation' (e.g. Kanzi commented "potato oil" after a researcher had put oil on him while he was eating a potato, o.c. 557). Since all partial or complete imitations of researchers' utterances (only 2.67 %) were omitted from the corpus, a degree of creative spontaneity (criterion 5) is clearly present.

One rule that Kanzi learned from his caregivers is *'action precedes object'*, an order he began to use to a statistically significant degree after about a month into the observation period. This rule remained "undisturbed by countertrends of individual lexical items" (o.c. 559; criterion 4), unlike with Nim, and clearly relates *categories* of symbols rather than individual symbols (cp. table 20.2 in o.c. 558-559).

An 'arbitrary' (not functionally motivated) rule which Kanzi coined himself is *'place gesture after lexigram'*. This is the exact opposite of the human caregivers' order, who invariably use a lexigram first. The arbitrary nature of this rule appears from this anecdote:

> At one point Kanzi was observed to move away from a person he would later indicate as agent, go to the board (where he indicated an action lexigram), and then return to the person (using the gesture to designate her as agent). In that situation, the rule Kanzi had invented demanded extra motor steps and therefore seemed purely arbitrary. (o.c. 560)

The rule pertains to four relations (creative productivity): agent-action, demonstrative-entity, goal-action, and agent-object. In the case of goal-action, the rule implied relations between two categories (lexigrams, and on the other hand, action gestures such as 'open', 'go', 'come'; criterion 3). In the other cases, however, only a demonstrative gesture was used.

Another rule invented by Kanzi is directly related to Kanzi's interests (games such as chasing and tickling, for instance): *preferred orderings for conjoined actions*. "Chase" and "tickle" tended to appear in the first position, whereas "hide", "slap" and "bite" usually appeared in the second position (criterion 3 and 4). "Grab" and "hug" showed no statistically significant position preference. The semantic reason (criterion 2) for this categorization is suggested to be that first-position lexigrams function as "invitations to play", whereas second-position lexigrams represent "the play content that follows" (Kuroda pers.comm. qtd. in Greenfield and Savage-Rumbaugh 1990:566). A later suggestion by Patricia Greenfield is that Kanzi "tended to place the actions that required a greater distance between the two parties in the first position and the action requiring closer contact between the two parties in the last position" (reported in Savage-Rumbaugh and Lewin 1994:162). This might iconically reflect primates' tendency to move from distal to proximal actions in their play (ibid.). A similar rule-governed verb order appears in human languages - even to a limited extent in English ('go get'). Interestingly, Kanzi's productive rule - 10 of 16 predicted combinations were attested - was imitated by his caregivers (whose communicative acts were studied on hours of videotape). The conjoined action rule is relevant to an evolutionary approach to language origins, according to which language evolved as "an instrument to plan coordinated action" (Greenfield and Savage-Rumbaugh 1990:568).

Difference in symbol order could signal difference in meaning: animate agents tended to be placed in the first position in lexigram-lexigram combinations ("Matata bite"), whereas animate beings functioning as objects of action were placed in the second position ("grab Matata").

Of Kanzi's three-word utterances (which, unlike Nim's, were not redundant), only action-action-agent was sufficiently productive during the observation period (e.g. "chase bite (person: demonstrative gesture)").

It would appear that Kanzi even produced the "rudiments of an *ergative* system in the face of the *accusative* model presented by his English-speaking caregivers" (o.c. 570) as he placed intransitive agents and transitive objects after the action symbol.

Kanzi's grammatical development was, of course, much slower than children's. For one thing, an ape's brains are only a third of the size of human brains (cp. infra). The fact that the amount of requests was far larger than statements (96 %) probably reflects at least in part

> a bias stemming from the fact that in captivity, a chimpanzee's behaviour and environment are under the control of humans, from whom he must request activities or objects. In the wild, a given animal might, for example, *state* his planned activity, rather than *requesting* it. This difference is quantitative rather than qualitative and may reflect a tendency on the part of the researchers to code chimpanzee statements as requests in the interests of conservative interpretation. (o.c. 568)

2.6 Rearing or species variable?

In order to determine whether bonobos were privileged in their language competence, a comparative study between a bonobo (Panbanisha) and a chimpanzee (Panpanzee) was set up. That they were co-reared, is extremely significant: from previous studies with chimpanzees one may have got the impression that chimpanzees were not capable of anything near the level of language comprehension apparent in Kanzi, Panbanisha and another bonobo, Mulika. However, in these previous studies, the chimpanzee subjects were older, and were taught on the basis of trial and reward, rather than observationally.

Both subjects learned to comprehend speech and lexigram use, but "the bonobo did so more extensively than the chimpanzee" (Brakke and Savage-Rumbaugh 1996:363). Indeed, Panbanisha acquired symbols earlier, more rapidly and in greater numbers than Panpanzee, she combined them in more novel and abstract ways and used gestures more often to stress her communicative intent (*Panbanisha and Panpanzee*: online). This is not to suggest that Panpanzee was not intelligent: she was considerably better at maze learning and puzzle working than both Kanzi and Panbanisha. She did also reach an important level of linguistic competency, though not as impressive as that of Kanzi or Panbanisha.

An illustration of Panpanzee's lag in language development when compared to Panbanisha in the realm of language *production* is offered in figure 2. The rate of early language acquisition is comparable to that of human infants. After this point, however, children's vocabularies start to increase very rapidly. That this is not the case for apes may be due to their smaller brain size, but also (in part) to the low number of symbols available on the lexigram keyboard (viz. 256).

Figure 2. Number of different lexigrams used non-imitatively at least once per month (Brakke and Savage-Rumbaugh 1996:368)

In conclusion, it appears that chimpanzees are also able to learn symbols spontaneously given the correct linguistic input (viz. early immersion in a language-rich environment). Indeed, the "rearing variable" is far more important than the "species variable" (*Panbanisha and Panpanzee* 1998: online). However, the lower scores for the chimpanzee when compared to the bonobo, suggest that they could be situated at the left on a continuum - rather than an 'all-or-none' division - as represented in figure 3:

Figure 3. Continuum of language competence

2.7 Sex, lies and videotapes: a Theory of Mind

As is argued throughout a number of publications by Savage-Rumbaugh and her team (and in short also above), comprehension precedes production and is a more relevant pointer of language competence: listening requires "the assumption of the perspective of others", and the assumption "that others have something to say that the listener does not know. In brief, listening requires what is called a Theory of the Mind" (Savage-Rumbaugh 1997:50). Language is not just about expressing oneself - which is roughly what Washoe and Lana could do - but about how individuals structure their interactions with one another, which entails the capacity to act in response to the expressions of other individuals. The results obtained with Sherman and Austin, Kanzi and Panbanisha showed that apes are capable of this. The latter two of these were also raised from infanthood in a language-rich environment, and developed impressive language skills, as reported above.

Such truly "language-competent" apes, as Kanzi and Panbanisha, can "easily participate in three- and four-way conversations - conversations that deal with the intentions and actions of multiple parties and with the states of minds of the parties" (o.c. 57). Savage-Rumbaugh reports an elucidating example which shows that Panbanisha can answer questions about what it is that someone else thinks is hidden in a box (o.c. 64). In a Theory of Mind test, Liz asks Sue for candy in Panbanisha's presence. Sue agrees to put some candy in a box for Liz. Then Liz leaves, and in Liz's absence Panbanisha watches as Sue replaces the candy with a bug. When Liz returns, she pretends to have difficulty opening the box, at which point Sue asks Panbanisha what Liz is looking for. Panbanisha responds by pointing to the lexigram for 'candy'. In addition, Panbanisha was able to comment on the fact that Liz had been deceived: she told the caretakers that they had been "bad" to play such a trick on Liz (o.c. 61).

The understanding exhibited by Panbanisha far exceeds mere understanding of syntactical structure: she understands that "the perceptions and states of knowledge of different individuals may not accord, and that the word *think* can refer to the nonobservable perceptions of others" (o.c. 59). At an earlier stage, infants have an "egocentric" view of the world, "in which they assume that others know exactly what they know"; Panbanisha however has reached the stage of exhibiting a "theory of mind" as she understands that "the minds of others are capable of registering information about their surroundings distinct from what they know to be correct" (o.c. 64). This is a quite remarkable feat.

Savage-Rumbaugh concludes:

> It is astonishing that apes that truly understand language can do all these things easily, even if their language production skills are typically limited to single symbols. Apes that do not understand language cannot do these things. We have no way of knowing, without language, why they fail. Do they not understand that different people can have different perceptions of events? Do they not know what is actually in the box? Do they know that things remain in boxes even when they are out of sight? (o.c. 62)

The key to a 'theory of mind' is exactly the ability to deceive with intent, according to Byrne and Whiten, such tactical deception being defined as "an individual's capacity to use an 'honest act' from his normal repertoire in a different context, such that even familiar individuals are misled" (1987, qtd. in Savage-Rumbaugh and Lewin 1994:272, cp. van der Helm 1999:49). For instance, several primate species have been observed to suppress sexual vocalization during clandestine mating or to suppress vocalizations to facilitate surprise attacks (Whiten 1994:3330); a baboon uttered a 'danger' cry in order to scare another baboon off and eat the abandoned food this baboon had been unearthing (Savage-Rumbaugh and Lewin 1994:273, after Byrne and Whiten 1987); and so forth. Whether these deceptions are indeed 'tactical' and hence with reasoned intent, is not certain. Of the 253 cases Byrne and Whiten collected from psychologists and primatologists, only sixteen were withheld as indisputable examples of 'tactical deception' (Savage-Rumbaugh and Lewin 1994:275). This is one of them, observed by Frans Plooij:

> An adult male was alone in a feeding area when a box was opened electronically, revealing the presence of bananas. Just then a second chimp arrived, and the first one quickly closed the box and ambled off nonchalantly, looking as if nothing unusual were afoot. Like Figan before him, he waited until the intruder departed and then quickly opened the box to retrieve the bananas. Unlike Figan, however, he had been tricked. The other chimp had not left but had hidden, waiting to see what was going on. The deceiver had been deceived. (o.c. 276)

Deception has also been reported in Kanzi's mother Matata and in Kanzi. Kanzi, for instance, will ask to play in the so-called T-room - not to play, but to steal M&M's which *he* knows are there (whereas Sue Savage-Rumbaugh does not know). "He does this so deftly and quickly, it is clear that it was his intent all along" (o.c. 278). Apart from deception, evidence of self-awareness and animal pretense has equally suggested that apes possess a 'theory of mind'. Examples of the former include Austin spontaneously using live video images to look down his throat; Sherman on the other hand to brush his teeth or apply lipstick; and Kanzi using a mirror to practice blowing up balloons and blowing bubbles with bubble gum (o.c. 265-267). As to the latter, Savage-Rumbaugh observes that animal behaviourists typically assume that animals do not know they pretend, while children do, simply because children can *say* that they are pretending, whereas animals cannot. Sherman and Austin, Kanzi, Panbanisha, all liked to play pretend games as youngsters (e.g. eating imaginary food, enacting *King Kong* while watching the movie on television; o.c. 277).

These abovementioned findings also suggest that primate communication in nature is not accurately characterized as "instinctive and devoid of meaning or intention" (Savage-Rumbaugh 1997:63). A tentative study reported in Savage-Rumbaugh et al. (1996) suggests that purposeful flattening and breaking of vegetation in the woods in various distinct patterns, serves to express different kinds of information about food locations. Similarly, three distinct gestures were observed in bonobo's mating behaviour (implying "the realization that personal desires can be communicated to another individual", Savage-Rumbaugh and Lewin 1994:113), ranging from direct touching to entirely iconic motions and serving to indicate preferred position, desired movement and nature of the desired movement (o.c. 112-113).

As to vocalizations, it has been demonstrated that they are meaningful in the wild. A well-studied case is that of vervets, which produce different alarm calls dependent on the type of predator. That these different calls do not simply indicate different degrees of fear, as had been suggested, was shown in an experiment conducted by Cheney and Seyfarth, "in which the only event was the playback of a previously tape-recorded vocalization" (Whiten 1994:3329). The results suggested that the calls *did* have a 'word-like' meaning: "the vervets ran up trees at a leopard alarm, looked up and took cover at an eagle alarm, and when a snake alarm was played they looked around themselves in the grass" (ibid.). Moreover, a degree of learning has been observed in infant vervets, who tend to overgeneralize but gradually refine the referent class for a call (e.g. only Martial eagles deserve an eagle alarm, and not harmless birds such as bee-eaters or storks; o.c. 3331). Sophisticated vocal communication about social events (type of opponent - i.e. of higher, lower or equal rank - and degree of aggression involved in conflicts) has been documented for macaque monkeys (o.c. 3329).

In comparing Kanzi's vocalizations to those of four non-language exposed bonobos, it appeared that four of the fourteen were unique to Kanzi, whereas the remaining ten were common to all five bonobos. These four seemed to be used in different contexts: as part of a request, in response to questions, after a question, and in response to queries. Savage-Rumbaugh hazards the guess that Kanzi may well be "trying to imitate human speech, or at least the inflection in such speech" (Savage-Rumbaugh and Lewin 1994:176). One thought-provoking event related by Savage-Rumbaugh is this: on one occasion, she had forgotten about her keys, which she had given to Tamuli (Matata's daughter) to play with. When she needed them, she asked them back from Tamuli in vain for fifteen minutes. She then asked Kanzi to tell Tamuli to give her the keys back, and this is what happened next:

> Kanzi climbed to the top of his room where wire mesh separated his area from Tamuli and looked at her while making a small noise. Tamuli approached Kanzi, looking directly at him. Kanzi made several multisyllabic sounds to Tamuli. Tamuli listened, then to my amazement quietly walked over and handed my keys back. Did Kanzi tell her to give me my keys? Did she understand him and comply? It certainly seemed so. (o.c. 263)

2.8 A glimpse of the evolutionary approach

The vast field of studies on the origin of language falls outside the scope of this paper. However, some short remarks on the evolutionary importance of language are appropriate. It seems that language is strongly interrelated with such conceptually demanding tasks as tool use (o.c.: Chapter 8) and planning ahead. Moreover, cooperation and even deception offer a selective benefit to bipedal (and therefore, less well protected) species. All of these tasks require a mental plan, and at least the latter two also a concept of 'self' and 'other'. Savage-Rumbaugh is inclined to think that language *faculty* existed prior to actual language. The arrival of spoken language on the scene would then have provided a means to realize already present potentials. The ability to produce the sounds of speech we are able to produce, may have been nothing but an evolutionary by-product of developing bipedalism. Indeed, the bipedal posture entails the "need to carry the head in a balanced, erect position over the center of the spine" (o.c. 226). Other changes occurred as a result of this, enabling early modern man to perform the velopharyngeal closure (i.e. "the brief blocking off of the nasal passages as air is forced through the mouth") required to produce consonants.

The lack of the ability to produce consonants is exactly what makes it impossible for apes to speak, as consonants serve to delineate meaningful units in the continuous air stream we produce as we speak. This is not to say that apes are not capable of *recognizing* consonants; in fact, it has been shown that they are capable of similar speech recognition as humans (o.c. 229-230, Whiten 1994:3330-3331). When one vowel is gradually shifted to another by a speech synthesizer, there will be a large area of transition where humans doubt as to whether the vowel produced is the first or the second (fuzzy boundary). For consonants, on the other hand, there *is* a clear cut-off point (cp. Crystal 1997:147 for [pa]-[ba]), and this categorical perception has been demonstrated for different kinds of mammals apart from humans (e.g. chinchillas, rhesus monkeys, Japanese macaques).

Another evolutionary difference that accounts especially for Kanzi's *limited* abilities is brain size: apes' brains are approximately three times smaller than humans'. This is, however, a *quantitative* difference: the frontal lobes of the neocortex (the outer layer of nerve cells), associated with planning and foresight, and the cerebellum, associated with the automatization of skills, for instance, have expanded disproportionately. The *structure* of the brain does not differ, so even all the areas involved in language comprehension and production (including Broca's area and Wernicke's area) are present in apes' brains (o.c. 223-224). This is a serious counter-argument to the Chomskyan idea of a uniquely human language-acquisition device (cp. infra), caused by some huge and sudden mutation. (Incidentally, the prevailing trend in current thought on evolution is to believe in *gradual* evolutionary change.) The selection advantage presented by the spectacular increase in brain size is suggested to be an increased ability to plan ahead. This is in turn linked up to better tool making: the ability to make a tool (and even an entire toolkit) at a given time, when it is not immediately needed, and to keep it for later use, is conceptually quite demanding (o.c. 238-240).

Apart from the observations concerning limited speech production and limited brain size, a general evolutionary principle can help to account for the limitations of apes' language abilities: "two related species generally are more divergent later in ontogenetic development, and more similar during earlier ontogenetic stages. (…) Applying this concept to language, one would expect chimpanzee's communicative systems to be more similar to the communicative systems of children during the earliest stages of language acquisition, less similar during later stages, and least similar during the adult stage" (Greenfield and Savage-Rumbaugh 1990:544). Indeed, it appears that only in the earliest stage of development, language comprehension and production is comparable to that of children (cp. supra: Savage-Rumbaugh et al. 1993).

3 The innateness debate

3.1 Chomsky on language acquisition

According to Chomsky, humans are born with an innate language ability, known as the *Language Acquisition Device* (LAD). A special organ in the brain, which constitutes a separately functioning cognitive module, is said to be responsible for this capacity. The LAD consists of a number of general linguistic regularities, referred to as the *Universal Grammar*. So when a child learns a language, it employs these rules for analyzing and comprehending the concrete language in which it is raised. Discovering the rules of which this UG consists has been Chomsky and his followers' (ongoing) dream. Ascribing language faculty to a genetic determination serves as an explanation for the rapidity with which human beings internalize and produce language. A fundamental assumption of the Chomskyans is the fact that the linguistic stimuli the child receives from its environment are insufficient to account for the extent to which a child learns and corrects the language it adopts. Moreover, parents do not frequently correct the syntactic errors their offspring make. The observation that children do not often make mistakes against phrasal movement or relative clauses, suggests to Chomsky that there must be some 'parsing device' which comes into action when the child internally analyzes language for production.

3.2 Behaviourism

Behaviourism (a.o. Skinner, Bates) states that language is a culturally acquired ability which is consituted by a stimulus-response behaviour on the part of the speakers.

New evidence seems to suggest that parents do in fact reformulate or query their children after ungrammatical utterances (Demetras, Post & Snow, 1986; Hirsch-Pasek et al. 1984; Penner, 1987). However, it is debatable whether the parents' feedback, if given, is still sufficient for the child to acquire an internal linguistic structure which it needs to produce syntactically correct sentences.

Savage-Rumbaugh alternatively suggests that a child corrects itself during the period before it actually produces language. When the child starts producing sentences, a number of mistakes will not occur, because it will already have corrected them in the comprehension stage.

The mistakes children make are due to 'overgeneralization' of rules, rather than errors in the general structural organization of the sentences. Children pull apart syntactic structures in the speech around them and do not develop grammar out of an innate parsing device.

3.3 Non-human primate language

With regard to NHP language acquisition, Chomsky's reaction is very concise as he refuses to join or even acknowledge the debate. Chomsky simply refutes the notion of animal language acquisition, regarding it as a uniquely human ability. Cindy Kandolf believes that language is a uniquely human capacity in the same way as a trunk is unique to an elephant. We should, however, not exaggerate its importance as a criterium for 'intelligence' (Kandolf 1995:online). The importance of language depends on the value we attach to it:

> What an irony it is that the supposed attempt to being Homo sapiens down a few notches in the natural order has taken the form of us humans hectoring another species into emulating our instinctive form of communication, or some artificial form we have invented, as if that were the measure of biological worth. The chimpanzees' resistance is no shame on them; a human would surely do no better if trained to hoot and shriek like a chimp, a symmetrical project that makes about as much scientific sense. In fact, the idea that that some species needs our intervention before its members can display a useful skill, like some bird that could not fly until given a human education, is far from humble! (Pinker 1995:342)

Recent studies (a.o. Savage-Rumbaugh), however, have shown that apes do have (to some extent) the ability to acquire language and even syntax.

It is assumed that an anatomical change, which occurred some two to three million years ago, 'equipped' humans with a capacity for language. The exact location of a 'language module' has not been pinpointed (yet?) by scientists. Data suggest that language abilities are to be situated in several parts of the brain or that they may shift from locations. Other studies have shown that language can be located in different areas in different individuals (Calvin & Ojemann, 1980). If this is the case, then it clearly contradicts Chomsky's assertion of a central language organ in the human brain. Consequently, this may further the behaviourists' belief that language is an individually acquired skill which each human being acquires as the result of a stimulus-response behaviour, i.e. through interaction with others.

In the 1970s and early 1980s it was generally assumed that animals could not produce speech at the phonemic level as humans do. Animals would lack the human speech module which decodes the complex and intricate sounds of human speech. Animals and humans each produce their own sounds, but they are unable to understand the speech of the other by a genetic inability to comprehend signals of other species than their own. As was shown above, apes clearly *are* able to understand even spoken English (Savage-Rumbaugh et al. 1993), and they are capable of the same categorical perception of consonants as humans.

The problem with early non-human primate language research is that it has been continually discredited by critics. The bulk of the criticism deals with the methodology by which researchers test their subjects for language recognition. One critic is Thomas Sebeok who believes that the case of the horse Clever Hans typifies ape language research in general. Clever Hans was the horse of the retired school teacher Wilhelm Von Osten who claimed that his four-footer mastered the numeral system. Apparently, the animal could count by tapping out numbers with its hoof. This mystery, however, was unravelled by the psychologist Oskar Pfungst (flaunting on the first page of Sebeok's book *Speaking Of Apes*) who revealed that the owner was unconsciously cueing the horse which continued until the horse reached the correct number. According to Sebeok, studies into ape language are similarly deceptive. His objections to ape language research are, however, not always objectively or scientifically founded. To him, ape language researchers are "involved in the most rudimentary circus-like performances" (qtd. in Wade 1980:1351) or "require success in order to obtain continued financial support for the project, as well as personal recognition and career advancement" (ibid.).

A serious blow to language research in non-human primates was Terrace's paper on Nim, referred to above. Terrace had taught a chimpanzee sign language: the ape learned signs and also started using them in strings. But Terrace's findings were that this ape learned these strings by heart and produced them to get some feedback from his caretakers. He did not reproduce these 'sentences' creatively to indicate new meanings. He was making monkeys out of his keepers by merely imitating them (o.c. 1349).

Sue Savage-Rumbaugh put up a research project where three bonobos were raised in a 'language-rich environment'. An important methodological difference with earlier research was the fact that the primates in question were spoken to by their caretakers and were not specifically language-trained. In addition to speaking normal English, caretakers pointed to visual symbols when talking to them. The results are remarkable and the apes did adopt language skills: they acquired both a vocabulary and a grammar, albeit a limited one.

Table 12

First 10 Words Acquired by Different Ape Subjects (Savage-Rumbaugh et al. 1993:41)

Kanzi	Mulika	Panbanisha
Orange	Milk	Milk
Peanut	Key	Chase
Banana	T-room	Open
Apple	Surprise	Tickle
Bedroom	Juice	Grape
Chase	Water	Bite
Austin	Grape	Dog
Sweet potato	Banana	Surprise
Raisin	Go	Yogurt
Ball	Staff office	Soap

3.4 Studies into comprehension rather than production

In a reaction to the 1993 *Monograph* by Savage-Rumbaugh et al., Elizabeth Bates asserts that the bonobo Kanzi has reached a level of language acquisition comparable to the capabilities of a 2-year old child. At the same time she agrees with Savage-Rumbaugh that studies into child and non-human primate language have put too much emphasis on production and too little on comprehension Bates goes on to claim that some progress has been made in the study of early language comprehension in recent years. She elaborates on this by adducing three methods which serve to investigate language comprehension in children:

3.4.1 Parental report

Parental reports are diaries in which parents report on the development of the linguistic skills of their children. Parental reports are generally considered useful, because parents are most likely to be present in situations where children learn their first words (e.g. feeding, bathing, going to bed). Researchers who only spend a limited time with a child, miss out on a lot of its new words. The criticism that parents will judge their offspring's competence too subjectively or favourably is refuted by Bates when she shows that parental reports have proven to be better predictors for the development of the child's later language skills. By bringing a number of parental reports together, Bates and other researchers have come up with a general checklist, giving a global assessment of lexical, gestural and grammatical ability before 30 months of age. Using this checklist, parents can follow their children's development, providing new data for further research.

There are, however, a number of limitations to the parental report. First of all, parents can only keep track of word comprehension up to about 16 months of age after which they tend to presume the child understands "just about everything". Secondly, parental reports reflect language comprehension as a process in which a number of contextual factors are at work, i.e. word acquisition is usually accompanied by parents making gestures or objects and events that are familiar to the child in question. How the same child performs out of context, remains unaccounted for. Thirdly, as the usefulness of parental reports ceases at 16 months, this method is insufficient to assess the emergence of receptive grammar.

3.4.2 Preferential looking

This test implies a setting where a child is confronted with two screens, displaying two opposite situations, e.g. one showing Big Bird hugging the monster while the other shows the Monster hugging Big Bird. While the child is confronted with these scenes, someone pronounces e.g. "Big Bird is hugging Cookie Monster" (Savage-Rumbaugh et al. 1993:227). Generally, the child will look at the scene corresponding to what was said. This is regarded as proof that several aspects of phrase and sentence comprehension precede production of the same form.

It should be noted, however, that this test relies on the assumption that the child will look longer at the screen displaying the utterance. For a large majority of children this is true. Tests on preferential looking in children under 6 months of age suggest that children will actually look longer at novel visual stimuli displaying situations that are contrary to expectations. Another problem is that these tests require docile children who are willing to sit on the parent's lap for at least 15 minutes looking at pictures. This test has also been avoided by Sue Savage-Rumbaugh and her colleagues as they have shown that chimpanzees are considerably less cooperative. Therefore, the preferential looking test would not prove reliable for the healthy, active, mobile chimpanzee.

3.4.3 Event-Related Brain Potentials

This is an electrophysiological technique to measure 'electric potentials' at the scalp, i.e. measuring how external stimuli affect the brain of the child. To measure this, the child is wearing a special helmet. A child is confronted with familiar and unfamiliar words which are registered on a 'comprehension wave' indicating the child's degree of comprehension when hearing these words. This 'comprehension wave' differs with children who are also able to produce these words. The ERP is an efficient method to distinguish between comprehension and production in children. This technique appears to have a number of advantages over the preferential- looking technique:

> (1) Although both measures require the child to pay attention to linguistic stimuli, electrophysiological measures make no assumptions about direction of preference (i.e. the assumption that children prefer to look at a "match"). (2) The preferential-looking method usually requires a complex coordination of visual and auditory stimuli, in contrast with ERP studies where auditory stimuli alone are sufficient. (3) Because the presentation of stimuli is so straightforward in ERP studies, most individual children can handle a relatively large number of trials. (4) Whereas preferential looking provides not a single, relatively unstable dependent variable (percentage of time looking at the "matching" display), ERP studies elicit a complex, multidimensional dependent variable, with variations in timing, amplitude, polarity and scalp distribution. Because of the complex and multidimensional nature of the ERP, it is possible (at least in principle) for electrophysiological researchers to detect fine-grained discriminations among linguistic stimuli and/or the characteristics of individual subjects. (Savage-Rumbaugh et al. 1993:229)

Given the similarities Savage-Rumbaugh observed concerning comprehension abilities in both bonobo and child, could there be similar patterns of brain activity in responses to known and unknown words? It has taken many years to develop the normative information required for the interpretation of brain waves in human infants and children. To apply this to another species, a totally new normative scheme would have to built up. Children are also not always willing to put on the hat, so it is unlikely apes will be very cooperative either.

3.5 Savage-Rumbaugh's reply to Bates

3.5.1 Productive-receptive skills

During the development of language in children, there is a difference in function between the two hemispheres: the right hemisphere mediates holistic-integrative processes and the left hemisphere analytic-sequential processes. The right hemisphere develops comprehension skills. Because of the motoric movement involved in speech, production requires a different set of skills, which are traditionally located in the left hemisphere.

All vertebrate organisms take in environmental information through a number of sensory organs and process the information provided by these different organs. Somehow the central nervous system needs to be connected to the sense organs, to determine which organ is sending a signal and also to be able to direct signals to the correct organ.

For a number of actions like eating, copulating, and moving there is a similarity across individuals within species and other species. The brain can thus be prewired to do a number of things in a specific fashion: these actions are called innate.

There are, however, a number of things that individuals do in a different manner. As mammalian brain size increases, there is also an increase in the number of things individuals do differently. This is considered learned behaviour. These processes are mostly invisible. Learning language is one of them.

Savage-Rumbaugh makes a division not between innate and learned behaviour, but between processing/synthesizing processes and active processes that guide the gathering of sensory information and produce observable complex learned patterns of behaviour such as language.

How can an organism evolve to perform things that are not prewired? Evolution has had to develop a mechanism which allows for environmental information to be connected with prewired information in a flexible way.

By using PET-scans, scientists have tried to locate skills within the human brain, but they do not localize skills, they only show us that during certain activities, some areas are more active than others: they do not tell us how the processes go about to achieve this.

So we may be able to see how our brain can tell our hands to move, but nothing about how we develop concepts.

Recent research on PET-scans in chimps does, however, begin to yield "very, very interesting results", as Duane Rumbaugh put it in a Newsweek article (Begley 1998:48).

> If the scans show doing a linguistic task activates circuits that mere hearing or remembering do not, says Pinker, one of the more incisive critics of ape language, "*that* would be interesting." (ibid.)

3.5.2 Synaptic vs. volume transmission

The standard model of brain function states that all information transmitted in the brain is conducted by the buildup and release of electrical potentials within individual neurons. It has recently been shown, however, that information transmissions can occur in the extracellular space as wel. This is referred to as volume transmission and is a rapid form of transmission. Exchange of information between neurons is called synaptic transmission, which transmits information slowly.

Synaptic transmission is designed to arrange and orchestrate motoric movements that are programmed in a specific way like moving a limb or a tongue in a specific coordinated sequence, as is required for speech. All humans produce speech in the same way. The coordinated movements of the tongue in speech needs to be refined by training, but the ability itself to produce speech appears to be prewired in the human brain.

Understanding language as well as choosing what to say, requires different skills than those involved in producing audible sounds. These skills cannot be prewired because they depend on the processing of vast amounts of information which differs on each occasion and for each individual. Humans can produce the same speech sounds, but how words are conceptualized in the brain differs from individual to individual. In this view, language is constituted by a varying cooperation between volume and synaptic transmission: this view has given way to attempts to locate language in the wiring of the brain rather than specific structures.

3.6 General conclusion for the innateness debate

Sue Savage-Rumbaugh and her colleagues have shown that chimpanzees *do* exhibit "some symbolic ability" and "some grammatical ability". The level of language ability is better with regard to comprehension than with production. This contradicts Chomsky's assertion that language is uniquely human. Since the fifties, scientists have shown the strong genetic similarity between humans and apes. This acceptance of the strong relationship between humans and non-human primates has lead to a slightly more agreeable climate for non-human primate language researchers to investigate language acquisition in both species.

Elizabeth Bates believes that it is time to do away with the idea that our brain is organized around content-specific faculties e.g. for language, music, faces, etc. The differences in language abilities between the human and non-human primate language faculty are, to her, not due to the lack of a language 'organ' or 'device' in the latter, but to the computational properties of neural systems that indirectly support language learning and language use in the former. In this view, language ability is constituted by the connection of different neural components in the human brain. The arguments she adduces for this are first of all, the fact that it has been shown that the areas which support language acquisition are not the same as the areas supporting maintenance and use of fluent language in adults. Secondly, studies of brain activity during language processing in the adult suggest that many different regions are at work when language is in use, also depending on the cognitive task: e.g. word comprehension, covert word production, categorization of words in a novel task, categorization of words in a familiar task, translation from one language to another, judgements of grammaticality, etc. So, when language is used, the whole brain is at work, rather than one specific part of it, as is claimed by Chomsky. At the same time research into language acquisition in both child and ape has taken a new course as it has shifted its focus from language production to the study of language comprehension in their subjects.

4 Conclusion

4.1 Discussing Kanzi's abilities

Let us try to summarize what Kanzi can do, and ask ourselves the question whether it could be qualified as "language". Symbolic communication arose spontaneously in Kanzi, "without the need for shaping or planned reinforcement of specific skills" (Savage-Rumbaugh et al. 1996:176). He understands the meaning of both lexigrams and spoken English. Vocalizations, glances and gestures are used to reinforce his intentional communications, and his utterances show some grammatical structure. Such constructions as recursion and conditional sentences are understood by Kanzi (e.g. "Kanzi, if you give Austin your monster mask, I'll let you have some of Austin's cereal", Savage-Rumbaugh and Lewin 1994:170). The prime condition for these abilities to arise is the early exposure to a language-rich and stimulating environment, enabling the ape to communicate about things which are of interest to him (such as playing games, travelling in the 50-acre forest at the Language Research Center to different food locations, etc.).

The problem in assessing these abilities is the strong tendency of many writers on the subject to apply a "double standard": what is considered a remarkable feat in a child, will often be reduced to a far lower level of achievement in an ape. In describing Kanzi's admittedly limited grammar as a "protogrammar", Dr. Savage-Rumbaugh points out that the same term should be used for the grammar of a human infant, as its abilities are on a par with those of Kanzi.

This stance would be quite unacceptable to Chomsky, of course. His idea of some kind of language module in the brain is, however, fundamentally problematic in at least two respects: (i) there is, up to date, no evidence whatsoever of a structure in the human brain that is missing from an ape's brain (but there is, of course, a quantitative difference, cp. supra and Terrence Deacon in Wassink 1998:online and Savage-Rumbaugh and Lewin 1994:225), and (ii) it runs counter to the whole idea of evolutionary continuity (hence Chomsky's designation as "the creationists' grammarian", Greenfield and Savage-Rumbaugh 1990:540): one would expect our nearest relative to show the rudiments of language.

As to (i), it might not be unreasonable to suggest that something like a language organ could be discovered, but then a similar device would be expected to be found in apes, following (ii). At any rate, Chomsky's apparent unwillingness to engage in a debate is quite incomprehensible and leads one to wonder, with Savage-Rumbaugh: "Can scientists speak to scientists?" (Savage-Rumbaugh and Lewin 1994:51). It would only be fair to pay the relevant publications in the field the attention they deserve, considering the amount of effort and methodological concern put into it (e.g. strict criteria for coding performances, coding by several observers, statistical analyses involving e.g. observer agreement, wide variety of tests, making available extensive corpora, etc.). It is, for instance, at least surprising to find that Jean Aitchison, in a 1995 article on the origin of language, fails to mention any of the results obtained with Sherman, Austin or Kanzi, in her assessment of the evidence from primate language (Aitchison 1995:2-5,9-10). She only looks into primate vocalizations and signing (which she does not consider as language), focussing on Washoe, Koko and Lana. Similarly, though less markedly, Gábor Gyóri only mentions one article (not by Savage-Rumbaugh's team) postdating 1988 in an article in the same 1995 monograph.

4.2 Is it language?

Most critics of Savage-Rumbaugh's claims hold that creativity and rule-governedness are prerequisites of language (e.g. Aitchison 1995:2, Akmajian et al. 1990:423). Clearly, Kanzi's utterances show some grammatical structure and he uses language creatively: 90 % of his utterances are spontaneous (Savage-Rumbaugh and Lewin 1994:144), and they are not only used to request things, but also to comment on events or to announce intended actions, and even to pretend or lie:

> Kanzi told us that he was looking for his mother, Matata, when asked why he was trying to crawl under the railroad ties. Panbanisha tore the "good" lexigram off the keyboard and gave it to us as a way of sealing her promise to be good. (…) Panbanisha tells me when it is raining outdoors. She also told me that the lady who visited has hair that looks like a mushroom – and she was really right. (o.c. 278)

Kanzi also replies appropriately to the most unusual requests. When asked to put some grapes in the swimming pool, Kanzi got out of the swimming pool, picked up some grapes from a towel with different foods on it, and threw it in the water. (Savage-Rumbaugh et al. 1998:67,139). Considering the extensive controlled laboratory tests (as reported among others in Savage-Rumbaugh et al. 1993, referred to above), it is quite astonishing to find that the scientific community keeps refusing to accept the facts as they stand, preferring instead to attribute Kanzi's performances to cueing, contextual information or even just good luck.

A more elaborate way of defining language was proposed by Charles F. Hockett, a contemporary of Chomsky's who was "unceremoniously eclipsed" by Chomsky "sprang[ing] to fame" after the introduction of his transformational model of grammar (Seuren 1998:215). Some of his thirteen criteria (Crystal 1997:400-401) relate directly to spoken communication. The only ability resembling speech is the ability to use vocalizations which do, of course, entail an *auditory-vocal channel* with *broadcast transmission and directional reception* of discrete, contrasting sounds (*discreteness*, cp. supra on vervet calls) and *rapid* *fading* – i.e. transitoriness of auditory signals (cp. Hockett's application of his features to gibbon calls in Crystal 1997:401 after Hockett 1960:10-11). Incidentally, the signs of sign language are equally transitory. Hockett even sees *total feedback* in gibbon calls (and hence, in ape vocalizations), as they allow for "speakers [to] hear and […] reflect upon everything that they 'say' " (Crystal 1997:401; added quotation marks ours).

Hockett called the ability to send and receive messages '*interchangeability'*. It is clear that all the primates used in recent research projects were able to both understand the signs of their caretakers and send out signs (whether using ASL or lexigrams and gestures). A number of apes also displayed the ability to sign or communicate not only when addressed; they would spontaneously report or ask something to their caretakers. This demonstrates once more the feature of total feedback: the primates can reflect upon everything they communicate. Chantek, for instance, showed an ability to rephrase or improve the articulation of a sign. In addition, the only function of the signs is to convey meaning, they do not have a biological or any other function other than signalling a meaning; Hockett calls this *specialization.*

The lexigrams which Savage-Rumbaugh's subjects used to communicate demonstrate that the non-human primate language shows a high degree of *arbitrariness*, which is another key feature in Hockett's description of language. The geometrical symbols on the keyboard, which were used to denote words like e.g. banana or toilet, show no resemblance to the actual concept referred to. It will also be remembered that Kanzi's invented rule for combining gestures with lexigrams is entirely arbitrary (in the sense of 'not functionally motivated'). Furthermore, the symbols "convey meaning through their stable association with realworld situations" (ibid.); they show a degree of *semanticity.*

Displacement, or the ability to talk about phenomena that are absent, is one of Hockett's most important criteria; especially deception is rated as the ultimate achievement of discourse ability. Both Koko and Chantek displayed a kind of 'Machiavellian intelligence' and even their caretakers estimated that the apes lied an average of three times per week. Furthermore, Chantek often signed about things or places that were not present at the time and Patterson recorded numerous instances where Koko signed about past events. Similar (and more extensively documented) remarks clearly hold for Kanzi and other apes at the Language Research Center.

Another important characteristic of language is said to be the *productivity* of its users. As mentioned above, Kanzi's "language" meets this requirement. In addition, some primates showed that they were able to express a new concept, for which they had not yet learned a word, by using old elements of their 'language'. Koko famously called a mask an 'eye-hat', whereas Chantek called contact lens solution 'eye drink'. This proves that the primates did not use their signs in a limited or fixed way.

Loulis, a chimpanzee who did not really respond to the training she underwent, showed yet another important property of language. Whilst prolonged training proved unsuccessful, she did manage to pick up over 50 signs spontaneously from other signing chimpanzees. Hockett called this *traditional transmission*, or the ability to learn language from the other language users. Similarly, Kanzi appears to have learned at least one symbol from another ape (viz. Austin): the motorically quite demanding handclapping gesture signifying "chase" (Savage-Rumbaugh et al. 1998:35-36).

Displacement, productivity and traditional transmission were not to be found in gibbon calls, according to Hockett, nor was his final criterion of *duality of patterning*: "The sounds of language have no intrinsic meaning, but combine in different ways to form elements (such as words) that do convey meaning (unlike animal calls, which cannot be analyzed into two such levels of structure)" (Crystal 1997:401). This criterion does not seem to apply to the signs of ASL nor to lexigrams.

Considering the fact that every linguist may have a different definition of language, a qualification such as Lyons' is certainly appropriate:

> The question "What is language?" is comparable with – and, some would say, hardly less profound than – "What is life?" (…). (Lyons 1981:5 qtd. in Crystal 1997:400)

The fact that different definitions of language might yield other 'results' in an assessment of apes' abilities is one thing. The fact that critics kept upping the demands each time a break-through was reported, is another. Clearly, there *are* insurmountable upper limits to an ape's abilities, mainly caused by limited brain size for as far as complexity is concerned, and an unsuited vocal tract with regard to speech production. One cannot expect an ape to use language as we do, but one can equally no longer deny that the capacity for language *is* present at a basic level. The research in this field may have been misled at times – Savage-Rumbaugh herself was known as a bit of a "disbeliever" back in the seventies (Savage-Rumbaugh and Lewin 1994:43-47) – but it quickly recovered the right track and forces attention to a number of important questions, such as: what is language? what is its origin? what do Kanzi's abilities tell us about language acquisition in children? how does the existence of a capacity for language in apes affect our view of ourselves – can we go on pretending to be the rightful rulers of the world? can Descartes' strict dividing line between 'body' and 'mind', and his subsequent denial of rational thought in animals, be maintained? might grammar not be *learned* rather than prewired? and finally, why are so many scientists unwilling to accept the idea of a continuity between the minds of humans and those of apes, almost 'on principle'?

In sum, recent research on language in non-human primates is a model of critical but open-minded, multidisciplinary scientific research, carried out with the greatest methodological concern. In addition, it has been of immense 'practical' importance to severely mentally retarded children and their families, as it was found that lexigram keyboards can be used succesfully to allow such children to communicate in spite of their handicap (cp. Savage-Rumbaugh and Lewin:chapter 7). On the whole, it is extremely sad that a significant part of the scientific community is not even prepared to engage in a serious debate of some sort.

"But the question whether it has a language faculty is a meaningless question and therefore nobody should talk about it."
(Noam Chomsky)

"Science is not about doing things people will believe. It must explore the phenomena that are out there, believable or not."
(Emily Sue Savage-Rumbaugh)

Quotes
The quotes at the beginning of this paper are taken from Savage-Rumbaugh et al. 1993:240 and Wassink 1998:online respectively. Those at the end of the paper were taken from Wassink 1998:online and Savage-Rumbaugh and Lewin 1994:176 respectively.

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Page design, based on K.U.Leuven CWIS templates: Lieven Vandelanotte
Last modified: 20 April 1999