

Pragmatic and Informative “Wholes”: the Evolutionary Roots of the Human Language

Abstract: the study of the origins of language has been the interest of several ungrounded debates which have often affected its scientific plausibility. In this paper, aiming at an internally consistent interdisciplinary approach, I will adopt Botha's "Windows Approach" (2006) in order to justify the following two assumptions concerning the evolutionary roots of human language: a) despite the uniqueness of human language in sharing and conveying utterances with an open-ended structure, some isolated components of our linguistic competence are somehow shared with non-human primates, grounding a line of evolutionary continuity; b) the evolutionary thesis which sustains that the very first "linguistic" utterances were holistic - that is whole bunches of sounds able to convey information despite their lack of modern syntax. I will address such suppositions through the comparative analysis of three constitutive features of human language: syntax, the semantic value of utterances, and the ability to attribute mental states to conspecifics, i. e. the theory of mind.

Keywords: language, evolution, non-human primates, windows approach, holistic protolanguage, semantics, syntax, theory of mind.

The aspects of things that are most important for us are hidden because of their simplicity and familiarity. (One is unable to notice something – because it is always before one's eyes) The real foundations of their inquiry do not strike people at all. Unless *that* fact has at some time struck them. - And this means: we fail to be struck by what, once seen is most striking and most powerful.

For a *large* class of cases – though not for all – in which we employ the word “meaning” it can be defined thus: the meaning of a word is its use in the language. And the meaning of a name is sometimes explained by pointing to its *bearer*.

Ludwig Wittgenstein

1. Introduction

Words, thoughts, and reasoning are all constitutive parts of human *natural* history. Each Human's ordinary life is so permeated by them that, as fate would ironically have it, they are one the most mysterious topics of studies accessible to the human mind; mysterious and difficult for sure, but nonetheless extremely fascinating.

I believe that one of the most efficient ways to explore such a complex phenomenon is through the study of its origins' dynamics, which can shed light on those features that distinguish it from other animals' systems of communication. In short, what makes human communication unique. Although very telling, this kind of approach is difficult. Language, indeed, unlike other phenomena addressed by evolutionary research, cannot be studied through paleontological data, as it has never fossilized on rocky stratifications able to indicate an evolutionary path towards *species* and time. Therefore, a very efficient method is to adopt an interdisciplinary, comparative approach focusing on the social and cognitive capacities of different species. Human language, indeed, relies on a set of morfo-syntactic operations whose intrinsic “organic” complexity makes humans unique. Nonetheless, in this paper I assume that some isolated components of our linguistic competence are somehow shared with other animals, having evolved for non-linguistic functions, and in simpler forms, creating a line of evolutionary continuity.

In particular I will present some cognitive aspects of monkeys' communication systems, which can shed light on the evolutionary path of language and, more precisely, on three constitutive components that I will keep separated merely for methodological reasons, regarding the idea that in the complicated network of language they are intimately related. These crucial components are: semantics, syntax and the ability to attribute mental states to conspecifics.

2. Methodology

In order to provide a scientifically valid contribution to the study of the evolution of language - a topic which itself tends to be an object of speculation – it is necessary to adopt a precise empirical methodology.

First, it is opportune to adopt an interdisciplinary approach to the topic, linking the different points of view and data within a coherent frame of concepts, which could lead to an increasing understanding of language and of its evolutionary dynamics.

In this direction, the “Windows Approach to Language Evolution”, proposed by Botha (2006) is a valid methodology, in my opinion able to root the research on language evolution in an informative empirical ground. According to Botha's suggestion, we should adopt a theory through which a phenomenon which in itself is not observable empirically, as it is the case of the origins of language, is explored (as through a window). To be

scientifically virtuous, such a theory - which the author refers to as the “window theory” - should be characterized by three basic features. First, it should be well grounded, i. e., as Botha states, «a “window inference” can be considered grounded to the extent that it is based on a window phenomenon whose properties are well-understood»¹. Second, it should be warranted, in the sense that it «has to take an empirical form which gives a systematic account of how properties of present forms of language and (properties of) stages in the emergence of language are interlinked»². Finally, the window theory should be pertinent: «[window] inferences can be pertinent – that is, about the evolution of the “right entity”, namely language – only if they are underpinned by a restrictive theory of what language is»³.

3. The nature of the first human utterances

Given such methodological assumptions, I will adopt the studies concerning monkeys and apes’ communicative systems as a conceptual window through which to observe the evolutionary path of human language. Specifically, I will use this conceptual frame of research in order to justify the evolutionary thesis according to which the very first “linguistic” utterances were holistic - that is to say whole bunches of sounds able to convey information despite their lack of modern syntax.

A fertile question to start the exploration of such issues from could be the following: shall we refer to the first *Homo* vocal units as mere representational labels attached to objects in the surrounding environment, or rather isn’t it more correct to conceive of them as functionally referential units? There are two opposite theses that follow this later approach in the present debate about language evolution. On one hand, Bickerton’s analytical model of explanation asserts that names were labels (mostly referring to environmental objects such as food or aggressors), whose increasing number and complexity consequentially gave rise to syntax⁴.

This idea collides with the holistic model of explanation, first proposed by Otto Jespersen in the early XX century⁵, and recently revived by Alison Wray, according to which the first meaningful units were not mere labels, but rather they had a complex intrinsic internal meaning: «In this holistic protolanguage the messages are semantically complex and agrammatical. [...] Simply, the whole thing means the whole thing»⁶. In particular, Wray’s idea is that the first hominids may have communicated by means of random sequences of sound, and among these, they then found regularities to which they associated agreed meanings and references (i. e. the signaler itself, the receiver, and the predicated object, on the basis of the pragmatical context of use. The first expressions were, according to her ideas - formulaic and internally amorphous, though efficient in their performative, *manipulative* purposes⁷. While maintaining the idea about the performative and holistic value of protolanguage, I will develop in the next chapter an argument about its mostly informative characterization.

In order to assess the plausibility of these two perspectives, I will propose a mental experiment. Let’s imagine a situation whose protagonists were the very first hominids who became aware of an imminent attack from a dangerous

¹ Botha P. Rudolf, 2006: «On the Windows Approach to language evolution», *Language and Communication*, 26, p. 134.

² *Ivi*, p. 137.

³ *Ivi*, p. 139.

⁴ Bickerton, Derek, 2002: «Foraging versus Social Intelligence in the Evolution of protolanguage». In: A. Wray (ed), *The Transition to Language*, pp. 207-225, Oxford: Oxford University Press.

⁵ Jespersen Otto: 1922 [2010]: *Language. Its Nature, Development and Origin*. General Books LLC, 2010, Chap. XXI.

⁶ Wray Alison, 2002: «Dual Processing in Protolanguage: Performance without Competence», in A. Wray (ed.), *The Transition to Language*. Oxford: Oxford University Press, p. 118. See Fitch W. Tecumseh, 2010: *The Evolution of Language*, Cambridge: Cambridge University Press, Chap. 14.

⁷ See *Id.*, 1998: «Protolanguage as a holistic system for social interaction», *Language & Communication*, 18, p. 51: «Protolanguage would, then, be a phonetically sophisticated set of formulaic utterances, with agreed function-specific meanings, that were a direct development from the earlier noises and gestures, and which had, like them, no internal structure. Each would be phonetically arbitrary, unrelated in sound to even those utterances that meant similar things».

predator, e. g. a leopard. Most likely, our very first ancestor would have given an alarm call, similar to that of the great apes. In this situation, would we translate such a vocalization as a simple name, or rather as a more complex message with an intrinsic emotional connotation, which could lead to an appropriate reaction somehow achievable by the utterance: “I’ve just seen a leopard... Behave in the proper manner!”? This question is not easily addressable. Consequently, it is necessary to proceed systematically into the analysis of the issue, shedding light on the nature of the different prelinguistic features which were constitutively necessary for the origins of the first human “linguistic” utterances.

In that direction, I will address the focus of the study on the communication system of our non human primate ancestor, with whom we share genetic traits inherited by a common ancestor. The idea is to think through three essential thematic cores which could have based a line of continuity (and discontinuity at the same time) between monkeys’ communication system and the human language: syntax, the semantic value of utterances, and the ability to attribute mental states to conspecifics, i. e. the theory of mind.

4. Semantics

Regarding the semantic level, the meaning value of primate alarm calls refers to several different domains. Eminent research on monkeys’ communication system such as Seyfarth and Cheney address this by defending the thesis according to which their signals are highly informative, given the agreed meaning of “information” as the reduction of uncertainty in the recipient⁸. Indeed, as they observe, the signal can be used by listeners to extrapolate information concerning the presence of food, the caller’s identity, the kind of predator and the urgency of the danger. Concerning the signalling of the presence of food, it’s worth remarking that recent research conducted by Zanna Clay and Klaus Zuberbühler on bonobos has revealed that:

captive bonobos at two locations produced five acoustically distinct call types when interacting with food: barks, peeps, peep-yelps, yelps and grunts. The production and distribution of these call types within a sequence was not random but was significantly associated with the preference score of the food⁹.

Similarly, alarm calls can indicate the presence of specific types of predators, and the related level of danger, eliciting the most appropriate behavioural response:

In many species that give different alarm calls to different predators, variation in predator type is the primary stimulus that determines which alarm call is given. [...] Like Diana monkeys, vervet monkeys have several specialized alarm calls. One is given to mammalian carnivores like leopards, another to large raptors like martial or crowned eagle, and a third to snakes (Struhsaker 1967). [...] In other cases, the relation between eliciting stimulus and alarm call type is more complex. [...] The eliciting stimuli for suricate alarms [...] include both predator type and some features of the immediate context that are correlated with caller’s perception of urgency.

⁸ Seyfarth, R.M., et al., in press: «The central importance of information in studies of animal communication», *Animal Behaviour* (2010), doi:10.1016/j.anbehav.2010.04.012.

⁹ Zanna Clay, Klaus Zuberbühler, 2009: «Food-associated calling sequences in bonobos», *Animal Behaviour*, 77, p. 1392. See Hauser Marc D., Marler Peter, 1993a: «Food-associated calls in rhesus macaques (*Macaca mulatta*). 1. Socioecological factors», *Behavioral Ecology*, 4, pp. 194–205.

Furthermore, by hearing the signals exchanged by two or more monkeys, the listeners can infer the kind of relationship and approach that exists between them, perceiving them as actors predisposed to behave according to specific social patterns, such as who is supposed to groom or threaten whom on the basis of the affiliated dominance rank:

In groups of long-lived, highly social animals, communication and cognition are linked to fitness. To survive, avoid stress, reproduce, and raise offspring who are themselves successful, individuals need both a system of communication that allows them to influence other animals' behavior and a system of mental representations that allows them to recognize and understand other animals' relationships. Because these mental representations concern animate creatures and are designed to predict behaviour, they include information (if rudimentary) about other individuals' mental states, and about the causal relations between one social event and another¹⁰.

These observations are concurrent with the thesis according to which monkeys' vocalizations have a semantic value. At this point, however, we should address the question whether there is a strict link between the sound of the call itself and the related meaning, or as it sometimes happens in human language (in the case of synonymy), whether the different calls could convey the same "meaning". Indeed, calls with similar acoustic features might elicit different responses. For instance, an eagle alarm call in vervet monkeys can lead a monkey placed on a tree to jump into a bush, while a monkey already located in a safe location doesn't react by moving to a different place. On the other hand, it is also true that calls with different acoustic features elicit similar responses: a leopard growl and a monkey's alarm call elicit the same behavioural response, which is climbing up a tree. As Seyfarth and Cheney (2010) observe, this phenomenon tells us that the recipients' response depends either on the physical properties of the signal and on the specific information they acquire from it. Also, as is shown by Zuberbühler *et al* (1997, 1999), female Diana monkeys do not respond to the shriek of an eagle if they were exposed to a correspondent male alarm call 5 minutes earlier, even though these two types of signals are acoustically completely different. This observation supports the thesis according to which monkeys do not classify sound merely on the basis of their acoustic features, but also by the semantic meaning they convey. Such considerations emphasise the hypothesis according to which monkeys are provided with mental representation of the object linked to the conveyed signal.

Finally, for the purpose of our study, it is necessary to emphasise - following the arguments in Cheney and Seyfarth (2007) - that monkeys' vocalizations are not referable to as mere automatic innate reflexes:

Monkeys, then, seem genetically predisposed to give particular contexts. But this is not to say that their vocalizations are entirely reflexive and involuntary. Although their call *repertoire* may be relatively fixed, their choice of whether to call or to remain silent is more flexible. [...] There is no obligatory link between the sight of a predator and the production of an alarm.

[...] Primate vocalizations are not involuntary reflexes, impossible to suppress. They are, instead, much more like the other behaviors in which animals choose to engage. As they go about their daily lives, baboons decide whether or not to vocalize, just as they decide whether or not to groom, play or form alliance. Their behavior depends on a complex combination of their own motivation, the particular situation at hand, and who else is involved. Primates can control whether they vocalize or not; what they cannot control are the detailed acoustic features of the calls they choose to produce¹¹.

Indeed, monkeys' vocalizations are linked to a mental representation of the referred object. This is clearly inferable through field observations regarding, for instance, the vervet monkeys, which are able to suppress a

¹⁰ Cheney Dorothy L., Seyfarth Robert M., 2007: Baboon Metaphysics. The Evolution of a Social Mind, Chicago: The University of Chicago Press, p. 270.

¹¹ *Ivi*, pp. 226-227, 233.

vocalization, whereas this had been previously emitted in correspondence with the viewing of a predator in the same context. Moreover, acoustically similar vocalizations can lead to different responses, relying on the involved subjects and on the specific situation in which they occur. These data tell us that the potential meanings of monkey alarm calls are not strictly fixed to a mere genetical level, but are, in contrast, bearers of associations learned through experiences and interactions.

5. Syntax

Recently, Peter Marler (2000) a researcher on animal communication, revived Martinet's concept of "duality of pattern", applying it to the overall analysis of animal signals. He uses the theoretical distinction between two main levels of syntax:

- the phonological syntax¹², which consists of the meaningless recombination of sounds into longer strings. This syntactic level concerns the rules for sound sequencing.
- the lexical syntax, whose rule of recombination concerns the generation of meaning within the sentence context.

For the purposes of this paper we will address the question whether there is any observable evidence that either of these steps, or at least some crucial aspects of them, are present in monkey communication systems, in order to find some evolutionary precursors of language. In order to avoid terminological confusion, it's worth emphasizing that with the term "syntax" I refer to the meaning modelled on the Greek word *syntaxis*, composed by "*syn*" (together, with) – and "*taxis*" (order, connection, coordination of the parts according to structural rules), which must be kept conceptually distinguished from the modern meaning of the term "syntax", intrinsically tied to the semantic values of the lexical units occurring within the sentence context.

Referring to the mere phonological syntax, we can find examples of it among the vocalizations of monkeys. Erroneously, indeed, it has historically been assumed that animal vocalizations are mere an acoustically graded continuum, in contrast to human utterances, which at a phonetic level are perceived as differentiated into phonetic discrete units. By this regard, Cheney and Seyfarth (2007) assert:

Given the potential ambiguity inherent in a graded series of calls, and the importance of distinguishing both between different call types and between the call of different individuals, it appears that baboon listeners have been under strong selective pressure to detect subtle distinctions within a graded acoustic continuum and to link these differences in acoustic structure with differences in individual identities, social events, predators and so on¹³.

In other words, monkeys are indeed able to categorize their communicative vocalizations into different acoustic features which convey different meanings, relying on contextual cues linked to the environment (presence of food or predators), to the social relationship occurring between the vocalizing monkeys (in the case of vocal interactions), or to the emotional state of the caller. The inferred meaning of the vocalization relies either on the acoustic physiognomy of the signal, or on the information acquired on the basis of associations experienced in the past.

¹² I use this term referring to the regulated combination of monkey vocalization sounds, which by themselves are not as differentiated as human languages phonemes.

¹³ Cheney Dorothy L., Seyfarth Robert M., 2007, pp. 232-233.

Concerning the second level of description adopted by Marler, the lexical syntax, with a good degree of certainty we can assert that its constitutive complexity is not widespread in animal communication systems, as it is one of the uniquely human competences. Despite having a holistic meaning, as we have argued in the previous chapter, primate calls cannot be broken into meaningful units, and on the other hand, there are no parts comparable to words which can be combined in any rule-governed structure within a meaningful sentence, conveying a message which would be more than the sum of its parts. Nonetheless, recent field research has revealed the existence of a few important exceptions concerning rudimentary cases of “vocalizations syntax”. Regarding this, Klaus Zuberbühler, a field researcher on the cognitive capacities of non-human primates has observed that the Campbell monkeys, a species living on the western Ivory coast, emit a pair of low “boom” calls before their alarm calls, in the presence of less dangerous situations such as a falling branch or the predator alarm call of a distant group. As the author asserts, it seems that this acoustic component somehow affects the overall meaning of the call:

[‘boom’ vocalization] is given in pairs separated by some seconds of silence and typically precedes an alarm call series by about 25 s. Boom-introduced alarm call series are given to a number of disturbances, such as a falling tree or large breaking branch, the far-away alarm calls of a neighbouring group, or a distant predator. Common to these contexts is the lack of direct threat in each, unlike when callers are surprised by a close predator¹⁴.

In this direction, a study conducted on the pottos reveals that this species uses two types of signals (pyows and hawks) whose inversion generates different meaning effects:

Series consisting of ‘pyows’ are a common response to leopards, while ‘hawks’ or ‘hawks’ followed by ‘pyows’ are regularly given to crowned eagles. Sometimes, males produce a further sequence, consisting of 1-4 ‘hawks’. These ‘pyows-hawk’ (P-H) sequences can occur alone, or they are inserted at or near the beginning of another call series. Regardless of the context, P-H sequences reliably predict forthcoming group progression. [...] *We conclude that, contrary to current theory, meaningful combinatorial signals have evolved in primate communication and future work may reveal further examples*¹⁵.

Although these data confirm the presence - at least in some species of monkeys - of the capacity to combine a few signals in a very rudimentary way generating qualitatively different meanings, they lack the general capacity to produce rule-governed call combinations.

6. Theory of mind

A study concerning the evolutionary dynamics of language cannot disregard the research on the precursors of the capacity that probably, more than any other, had a key role in determining the specificity of human cognition: the ability to attribute mental states to conspecifics within a frame of shared intentions and joint actions.

It’s worth asking, then, if non-human primates are equipped with some correspondent ability. In order to address this question, it’s necessary to distinguish the signaler’s perspective from the receiver’s one. As Seyfarth and Cheney assess, indeed, the formers are not aware of the state of knowledge of the receivers, neither communicate they on the

¹⁴ Zuberbühler Klaus, 2002: «A syntactic rule in forest monkey communication», in *Animal Behaviour*, 63, p. 294.

¹⁵ Arnold Kate, Zuberbühler Klaus, 2008: *Meaningful call combinations in a non-human primate*, in «*Current Biology*», 18, pp. 202-03 (my emphasize).

explicit goal to change it. Nonetheless, on the other hand, the achieved effect is to supply the listeners with useful information, or to cause an emotional and behavioural response:

[...] the co-evolution of caller and recipient has favored signalers who call strategically and listeners who acquire information from vocalizations, using this information to represent their environment. The inability of animals to recognize the mental states of others places important constraints on their communication and distinguishes animal communication most clearly from human language. With the possible exception of chimpanzees, animals cannot represent the mental state of another. As a result, whereas signalers may vocalize to change a listener's behavior, they do not call with the specific goal of informing others or in response to the perception of ignorance in another. Similarly, whereas listeners extract subtle information from vocalizations, this does not include information about the signaler's knowledge. Listeners acquire information from signalers who do not, in the human sense, intend to provide it¹⁶.

Ultimately we can then state that monkeys are not able to attribute mental states to other individuals, as far as their behaviour can tell us. These considerations highlight the importance of such an ability in founding the evolutionary passage from monkeys' communication system to human language. An exception in this sense is given by chimpanzees, who seem to have a rudimentary theory of mind, concerning in particular, the understanding of the relationship between seeing and knowing. This means that they seem able to infer the acquired objective representational states of other individuals, relying on what these latter see, although they lack of the ability to understand other's beliefs and desires in intentional terms.

7. Could we see a holistic proto-language through monkey communication system?

We aim at using the data discussed above as a window through which the evolution of language can be studied. According to the methodological criteria proposed by Botha, this approach satisfies the three conditions of warrantedness, groundedness and pertinence. Indeed, the attempt to apply the study on non-human primates to the research about the origins of language is empirically supported by the well warranted assumption that humans and monkeys belong to the same phylogenetic line, thus sharing a common ancestor with their same socio-cognitive heritage. Moreover, an overall analysis of their vocalization system has been carried out well (although further investigations are still necessary). This allows us to recognise that the criterion of groundedness of the theory is satisfied. Finally, the condition of "pertinence" is guaranteed by the identification of language with a propositional system saturated with social practises and acquired experiential associations whose meanings are ontologically tied to the pragmatic and emotional situation whereas they occur. The goal of the present research is to find the evolutionary roots of the so intended "language".

Such observations support the adoption of the holistic model proposed by Alison Wray (1998, 2002) as more plausible than the analytic one proposed by Bickerton. Indeed, although the signalers are not able to communicate intentionally (that is, with a conscious, explicit aim to provide other individuals with specific information) – the listeners are nonetheless able to get from such unintentional utterances an arrangement of complex meanings, not reducible to mere lexical labeling. Regarding this last point, it's noteworthy to remark Cheney and Seyfarth's observations about primates' alarm calls:

¹⁶ Seyfarth, M. Robert, Cheney, Dorothy L., 2003: «Signalers and Receivers in Animal Communication», *Annu. Rev. Psychol.*, 54, p. 168.

Baboon alarm calls, like those of other primates, are thus holistic utterances, simultaneously both eventish and objectish because they incorporate both reference to an object and a disposition to behave toward that object in a particular way¹⁷.

8. Conclusions

Although recognizing the scientific plausibility of the first human utterances' holistic nature is an important step in the study of the origin of language, such assumptions open new questions to address. For instance, it would be opportune to focus the study on the specific dynamic concerning the evolution of the levels of intentionality above the first order, which determined the evolution of human language specificity, and its causal relationship with the evolution of social intelligence, which led to the ability to share thoughts, the target of attention and actions. A second question to address concerns the pragmatic and cognitive process that – within an increasing complex frame of shared attention and actions – grounds the development of the holistic messages into open-ended, syntactically structured sentences. Maybe the eventual answers could lead to a closer examination of the windowss theory we are adopting, thus allowing us to get an increasingly clearer view of the evolution of propositional language.

Bibliographic References

Arnold K., Zuberbühler K., 2006: «The alarm-calling system of adult male putty nosed monkeys, *Cercopithecus nictitans martini*», *Animal Behavior*, 72, pp. 643--53 (2006)

Bickerton Derek, 2002: «Foraging versus Social Intelligence in the Evolution of protolanguage». In: A. Wray (ed), *The Transition to Language*, pp. 207-225, Oxford: Oxford University Press.

Botha P. Rudolf, «On the Windows Approach to language evolution» *Language and Communication*, 26, pp. 129-143

Cheney Dorothy L., Seyfarth Robert M., 2007: *Baboon Methaphysics. The Evolution of a Social Mind*, Chicago: The University of Chicago Press.

Fitch W. Tecumseh, 2010: *The Evolution of Language*, Cambridge: Cambridge University Press.

Hauser Marc D., Marler Peter, 1993a: «Food-associated calls in rhesus macaques (*Macaca mulatta*). 1. Socioecological factors», *Behavioral Ecology*, 4, pp. 194–205.

Hauser Marc, 1996: *The Evolution of Communication*, Cambridge: Mit Press.

Jespersen Otto: 1922 [2010]: *Language. Its Nature, Development and Origin*. General Books LLC, 2010.

¹⁷ *Ivi*, p. 256.

Marler P., 2000: «Origins of Music and Speech: Insights from Animals», in N. L. Walli, B. Merker, S. Brown (ed.), *The origins of Music*, Cambridge: MIT, pp. 31-48.

Seyfarth Robert M., Cheney Dorothy L., 2003: «Signalers and Receivers in Animal Communication», *Annual Review of Psychology*, 54, pp. 145–73.

Seyfarth, Robert M., et al., in press: «The central importance of information in studies of animal communication», *Animal Behaviour* (2010), doi:10.1016/j.anbehav.2010.04.012

Wray Alison, 1998: «Protolanguage as a holistic system for social interaction», *Language and Communication*, 18, pp. 47—67.

Wray Alison, 2002: «Dual Processing in Protolanguage: Performance without Competence», in A. Wray (ed.), *The Transition to language*. Oxford: Oxford University Press, pp. 113-137.

Zanna Clay, Klaus Zuberbühler, 2009: «Food-associated calling sequences in bonobos», *Animal Behaviour*, 77, pp. 1387-1396.

Klaus Zuberbühler, Ronald Noë, Robert M. Seyfarth, 1997: «Diana monkey long-distance calls: messages for conspecifics and predators», *Animal Behaviour*, pp. 589-604.

Zuberbühler Klaus, Cheney Dorothy L., Seyfarth Robert M., 1999: «Conceptual Semantics in nonhuman primates», *Journal of Comparative Psychology*, 113, 1, pp. 33-42

Zuberbühler K., 2002: «A syntactic rule in forest monkey communication», *Animal Behaviour*, 63, pp. 293—299.