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Symbolic Communication in wild chimpanzees?

The language abilities of captive chimpanzees give rise to the question of the existence and use of similar capabilities in wild chimpanzees. In Tai forest, wild chimpanzees seem to use drumming on buttressed trees to convey information on changes of travel direction, resting periods or both information combined. This communication system is iconic and relies on some arbitrariness. Emergence of symbol-like communication in wild chimpanzees seems mainly dependent on a low visibility environment, a high predation pressure and a large group of males.

Introduction

Captive studies show young chimpanzees to possess surprising symbolic abilities (FOUTS, 1975; GARDNER & GARDNER, 1971; PREMACK & PREMACK, 1983; SAVAGE-RUMBAUGH *et al.*, 1978, 1980), that could be increased spontaneously if subjects were provided with a mother and an attractive social environment (FOUTS, 1983; FOUTS *et al.*, 1982; SAVAGE-RUMBAUGH *et al.*, 1985; SAVAGE-RUMBAUGH & RUMBAUGH in press). Such observations have prompted the question about the existence and use of similar capacities by wild chimpanzees; some have proposed that it was the language training that allowed chimpanzees to acquire new abilities (PREMACK & PREMACK, 1983), while others, including myself, suggest that these abilities are present in the wild but have yet to be discovered.

We present here a case of spontaneous use of drumming and vocalisation by wild chimpanzees to communicate intentions about travel movements to other individuals, which seem to incorporate aspects of symbolism. The present study, due to its totally natural setting, lacks the precise experimental control of the ape-language projects and the laborious training period involved the observer rather than the chimpanzees.

Methods

Hedwige Boesch and myself began a study of the wild chimpanzees in the Tai National Park, Côte d'Ivoire, in September 1979. This park is covered by largely intact tropical rainforest with visibility on the ground rarely exceeding 20 meters. Our first objective, besides collecting basic data on nut-cracking behavior, was to habituate the study community without relying on artificial provisioning (see BOESCH & BOESCH 1981, 1983, 1984 for more details on methods).

Tai chimpanzees forage typically in ever-fluctuating parties of 7-12 individuals remaining permanently in auditory contact with the majority (72%) of the community (80 chimpanzees) and move in a set direction for hours even when totally silent. Commonly, the community splits into a least 3 major parties that may communicate with one another

by vocalising and drumming. Buttressed trees are abundant in this forest and adult males, after loudly pant-hooting, hit these buttresses powerfully and rapidly with their hands, feet or both; this is called «drumming». Tai chimpanzees drum quite frequently, on the average once every 10 minutes (sample: 12 consecutive days, i.e. a total of 87.25 hours of observation).

Drumming is a way for the males to communicate their position to other group members and it may inform them about the direction in which the drummer progresses, and, since males form the core party of the community at Tai, contains information about their progression. However, we suspected that these drummings were more than just an indication of individuals' positions in this dense habitat because we tended to lose contact with them just after drumming was heard. It seemed that the whole chimpanzee community abruptly and often silently changed direction following an outburst of drumming.

It took many months to unravel this communicative system. During this time, I learned to differentiate the pant-hootings of the individual adult males. In early 1982, although the habituation was still incomplete, I began to realize that it was only after Brutus, the alpha male, drummed that the community reacted by abruptly changing the direction of travel. On some occasions, Brutus's drumming sequence appeared to transmit a specific message. There was no difference in sound between sequences which did or did not contain such a message; rather, this message was indicated by the spatial and numerical combination of sequences. In some cases, Brutus might accentuate his message by hitting a buttress with just one hand in a very slow and irregular rhythm for almost an entire minute before starting to pant-hoot. Drumming may occur without vocalisation, but identification of the drummer based only on rhythm is impossible and our analysis is based only on drumming following pant-hooting.

From January 1983 to May 1984, whenever I recognized Brutus's distinctive voice, I recorded his drumming, his position and the positions and reactions of other group members, by sight or by the direction of their vocalisations. My ability in differentiating the other males' voices improved as the process of habituation progressed, until in February 1984, when I could confidentially identify 6 of the 10 adult males by voice, the observations were abruptly interrupted by the disappearance of 4 of them, probably due to poachers.

Results

Individuality

Any accurate analysis of the communicative effects of a call requires that the observer is sure of the identity of the caller. With some experience, chimpanzees' voices can be differentiated (GOODALL, 1968; MARLER, 1976), and the pant-hooting-drumming sequence (first a series of «hoo» calls, then drumming and finally a climax scream) is clearly distinguishable. For example, in early 84, Brutus pant-hooted with a rapid staccato rhythm, producing an exceptionally long series of rapid hoots. In addition, his screams were the loudest of all males. Schubert, a young prime male, pant-hooted slowly at first and was the only one that screamed twice. Le Chinois hooted by opening widely his mouth, thereby producing a «hooa» sound very different from the normal «hoo» of other males. Snoopy was the only male that drummed at the end rather than before his climax scream. In addition, the intonation and the quality of the voice of each individual is quite characteristic.

Male chimpanzees seem to be aware of the importance of possessing clear individualised calls. This was obvious when Le Chinois disappeared in February 1984. Thereafter, Macho changed his formerly atypical pant-hood sequence so that within 3 weeks he was using exactly the same «hooa» sound as Le Chinois had previously. I was so confused that for many weeks I had to check if the Chinois had not come back. Similarly, shortly after the 4 males disappeared from the community, Brutus stopped producing his long series of rapid hoots and instead made a shorter and more usual series of slower hoots. Then, Falstaff, the oldest male of our community, started to produce exactly the long series of rapid hoots that Brutus had used previously. Falstaff used them until his death in 1987.

For wild chimpanzees it may be critical to be able to identify individuals' voices; for example, in social contest males commonly rely on an ally and we have observed, just before social conflicts, that males will search for their ally in other parties, knowing his location from previous calls. More importantly, at Tai neighboring communities are always spotted and recognized as strangers on the basis of their vocalizations. Males react immediately to the voices of strangers to prevent them from attacking females and their infants (BOESCH & BOESCH, 1989, pers. obs.; GOODALL, 1986; NISHIDA, 1979). Knowing each others' position, males of a community can assemble rapidly and silently before attacking the intruders.

Communications about group travel movement

During the 16 months in which I collected data on Brutus' drummings, I noticed no special reaction by other group members to a single burst of drumming produced by Brutus. Accordingly, I didn't record them, concentrating only on multiple drummings produced within a short space of time (less than two minutes). From these sequences, I was able to identify 3 types of message:

1) *Change in the travel direction*: Brutus, by drumming first on one tree and then on another indicated to other community members from the orientation of the trees the next direction he was proposing to take. In addition, such a drumming sequence always occurred within a time interval not exceeding 2 minutes. Individuals that were not part of Brutus' party, apparently inferred the new direction by mentally visualizing Brutus' displacement between the two trees and then transposing it to their own direction of travel. *Table 1* summarizes the number of occurrences in which I could identify the transfer of information about direction.

Example 1: On 6 February 1983, the direction of travel has been north-east since 12h40. I follow a noisy party moving about 400 m in front of me. At 14h00, Brutus, about 100m directly behind me, drums clearly twice; first along the axis of travel but the second obviously offset to the right. I think Brutus is suggesting a change of direction to the east. I make contact with Brutus who, silently and alone, is moving east/north eastwards in a leisurely way. After half an hour, he rests with an adolescent male that had joined him. Then, Falstaff and Darwin, two males from the leading party now heading south-east, come towards me and rest nearby, some 40 m from Brutus and probably unaware of his presence. Forty minutes later, responding to the leading party that is now clearly further east of their former location, Brutus, pant-hooting, goes north-east to join them. Falstaff and Darwin head further east, in the direction proposed by Brutus 80 minutes earlier. As this example shows, Brutus may stray away from the direction he proposed in order to feed or to join other group members.

2) *Resting period*: On other occasions, Brutus seemed to propose a resting period of a specific duration that the community would take: this was communicated by drumming twice on the same tree within 2 minutes. I was able to identify this message from Brutus in 14 cases (see *Table 1*), when the activity of the community stopped for an average of 60 minutes (N = 12, range = 55 to 65 minutes). The community was judged to be resting by the absence of vocalisation of parties not under observation as well as by the behavior and lack of movement by the party being watched. After this rest, the parties began to move again, sometimes vocalising. A chimpanzees' resting bout in the wild usually approximates to an hour and Brutus was probably proposing the timing of a rest rather than its duration.

Example 2: the 27 December 1983, I make contact with the chimpanzees at 12h14. Their direction of travel is south/south-eastwards. I follow the leading party in which many chimpanzees are cracking nuts up in the trees. At 13h50, Brutus, 200m behind me, drums clearly twice on the same tree on the axis of the general movement. I come upon Wotan, the beta male, with another male sleeping on the ground. After some time, they join 5 other chimpanzees eating in a tree some 50m away. At 14h48, i.e. 58 minutes later, Wotan initiates movement farther to the south/south-east. After 20 minutes of walking silently, we hear Brutus for the first time since 13h50; he is leading a party about 200m ahead of us.

Once I heard Brutus drum 4 times on the same tree, after which the community stopped for 2 hours 16 minutes. One example is not enough to draw any conclusions, but suggests that the number of bursts of drumming might indicate the length of the resting period.

3) *Change of direction and resting period*: By combining both messages, Brutus could propose both a change of direction and an hour's rest; in such a case he would drum once on a tree on the axis being travelled and then twice on another tree in the direction he was proposing to take (see *Table 1*) within two minutes. Alternatively, Brutus might drum twice on a tree on the axis and then once on another tree to indicate the proposed direction. In both cases, the information about the rest had an immediate effect, whereas that about the direction applied only later. It is worth noting that if Brutus were simply adding information about direction and time, he should have drummed 4 times (twice for each piece of information). In effect, he combined them and drummed only three times; thus, one of the burst of drumming contained information on both direction and time.

TABLE 1 - *Brutus's communication system with the frequency of emissions in which communication about travel direction and resting duration could be identified. One sequence «pant-hoot; drumming and climax scream» is labelled as unit. The number of cases heard corresponds to the number of responses of the group members in agreement with my understanding of the message, except for one case of 1 hour rest, in which Brutus himself cancelled his resting message by drumming farther away 7 minutes later. No disagreement between my predictions and the chimpanzee responses occurred.*

Number of units	Location of emission	Number of cases heard	Group response
2	same	8	1hour rest
2	different	8	Change of direction
3	same	—	—
3	different	6	1 hour rest + change of direction
4	same	1	2 hours rest
4	different	—	—

Example 3: the 12 January 1983; the community has been moving west since 8h30. I am following Macho, who moves between two larger parties. At 9h45, Brutus, 100 meters behind us, drums once on the axis of travel and about 1 minute later twice on another tree more to the south. Macho listens to Brutus, but goes farther west to contact a large party cracking nuts and he rests with some of them on the ground. At 10h45, i.e. 1 hour later, Macho and his party move south, where they contact Brutus, who is moving silently south-west. Then, all move off together farther to the south-west.

The context of Brutus's emissions seemed to play a role in the interpretation of his code. During social excitement, bursts of drumming did not appear to contain information. Also, drumming just after a resting period was made and interpreted in a different way. Prior to a rest, the code seemed to be used by Brutus and understood by community members exactly as explained above. Immediately after a rest, however, Brutus could communicate a direction change, while simultaneously confirming the beginning of group activity by drumming several times. If he drummed twice or 4 times on the same tree, this would not, in this context, be interpreted by other community members as a proposal to extend the resting period. Community members interpreted the message to contain information on a change of direction only and appeared to ignore the numbers of bursts of drumming on the same tree (2 observations).

Discussion

Tai chimpanzees seem to use some of their pant-hoot-drumming sequences to convey precise information about group movements. I am aware of the important limitation of the data presented here; when I was in the position to begin systematic data collection on this topic, in February 1984, the group lost 4 of its 10 adult males including 3 prime males and a promising young adult. This social change had a dramatic influence on the system of communication: Within 3 months, Brutus stopped sending information to other community members. We waited 6 more years, hoping that the rise to adulthood of 3 adolescent males would replace the missing males and recreate the conditions necessary for Brutus to communicate about directions. Unfortunately, further social changes prevented the number of adult males from rising above 7 and Brutus was never heard to use this communications system again.

Thus, I am unable to answer the question: how many times was the information conveyed by Brutus actually followed by community members, since I recorded only those I could interpret as containing such information. If numerous drumming sequences by Brutus were not acted upon by the others, this would challenge my interpretation of the data presented in Table 1. However, drumming by Brutus in quiet social contexts was conspicuous and emphasised by repetition. Thus I do not think I missed many of them. In spite of this limitation, I believe that these observations constitute an example of communication that contains some aspects of symbolism in wild chimpanzees and are of theoretical interest for understanding the conditions favoring the evolution of symbol-use in animals.

Evolution of symbol use

Previous authors (FOUTS, 1975, 1983; FOULTS *et al.*, 1982; GARDNER & GARDNER, 1971; PIAGET, 1945; PARKER, 1987; PREMACK & PREMACK, 1983; RISTAU & ROBBINS, 1982; SAVAGE-RUMBAUGH *et al.*, 1978, 1985; TERRACE, 1983; VOLTERRA, 1987) have

defined the term symbol to incorporate: first, a distinct dissociation between the referent and the signal that refers to it, second, generalisation in the use of this signal in the absence of the referent and, third, that the signal has communicative value informing about forthcoming behavior of the emitter and may thus alter the receiver's behavior. Brutus's communicative system informs other group members about external events and is thus shared and has a primary communicative value. This system is arbitrary in the sense that the pant-hoot-drumming sequence itself has no direct connection with the notion of direction or of time. However, it is not totally arbitrary but rather iconic since the movement performed by the emitter between bursts of drumming directly refers to the information conveyed. In this communications system, the iconic unit, as a symbolic one, stands for something.

The combination of two pieces of information, direction and rest, is more arbitrary and bears some analogies with human Morse code. Brutus's code used one unit (the pant-hoot-drumming sequence) combined with two variables, its number and its location. It is worth noting that when Brutus combines resting time and direction, one drumming sequence contained information on both time and duration. This system shares some similarities with that used by deaf children to communicate with their hearing parents, i.e. spontaneous gestures that preserve some resemblance to the referent and that they can combine in two or three-word sequences (GOLDEN-MEADOW & MORFORD, 1985).

The maintenance of this system is dependant upon the comprehension of it by other group members. Comprehension here seems more demanding than production. The receivers, often out of visual contact with Brutus has to mentally visualize Brutus's location from his drumming, and infer his movement between them, to understand the proposed direction. Tai chimpanzees may be silent for long periods of time and normally the group would follow Brutus' proposals without any vocalisation, with no sound being made for the next one or more kilometers, as in the third example given above. Therefore, the risk of losing contact with other community members is real if receivers are unable to make such an inference. Once, after 2 clear drumming sequences by Brutus on the same tree (which means an hour rest), a group of 4 young adult males and some young females continued, apparently unconcerned, in their group movement. This led to one of the rare community separations (where parties were out of auditory contact) at this time of year. One possibility may be that these young individuals didn't understand Brutus's signal and lost the others that followed his instructions.

Observations on Tai chimpanzees suggest that ecological and socio-psychological conditions play a joint role in favoring the evolution of symbolic communication. Wild chimpanzees living in large multi-male groups have to find an optimal compromise between the need to disperse, so that all group members can satisfy their feeding requirements, and the need to keep close contact so that there can be effective response to the sudden appearance of predators or of neighboring communities. This conflict of interest in a low visibility forest has forced them to adopt an acoustic communication system. The commonly used method in primates is to communicate frequently by using short, quiet contact calls between individuals out of visual contact, as occurs between members of *Cercopithecus* or *Colobus* monkey groups in the Tai forest. However, chimpanzee community members forage more widely apart than do the monkeys and would need to use much louder calls, such as their long distance calls (hooting), to keep in contact. If used frequently such loud calls would be a perfect lure to attract predators. In Tai forest, there is a large leopard population, as is characteristic of dense forests, (about 1 individual per sq km., MYERS, 1976). In the last 4 years, we have observed 7 adult members of the community with bad wounds that can only be attributable to leopard attacks. Subsequent-

ly one of them, an adult male, died of complication resulting from the perforation of his pleural membrane, most probably caused by the canine of a leopard (BOESCH, in press). Hence, under the *combined effects of poor visibility and high predation pressure*, Tāi chimpanzees may have been forced to adopt a sophisticated acoustic system to communicate information that coordinate community movements.

The importance of another ecological factor is suggested by the fact that *all but 2 of the 23 observations occurred during the Coula nut season*, from December to March. This season succeeds the rainy season and is the richest of the year in terms of fruit abundance, since many of the forest's most common tree species, such as *Coula edulis*, are fruiting. After March, fruit production decreases and large fruiting trees are less common. I think that this shift from an almost *continuous distribution of fruits to a more patchy distribution* is important: it is more difficult to preserve the cohesion of the community when high-quality food is distributed continuously rather than in discrete patches.

Similarly community cohesion was more at risk when it included a large number of influential males prior to February 1984. With 10 adult males there may have been increased pressure on the leader to give clear signals in order to reperseve community cohesion. After February 1984, this pressure vanished with the loss of 4 of the 6 highest ranking males. The relevance of the socio-psychological conditions is suggested by Brutus's progressively less frequent use of symbolic communication after the disappearance of these 4 adult males. In *Hamadryas* baboons, adult males may propose different directions by moving successively in different directions before the troop leaves the dormitory cliffs in the early morning, but the older ones make the final decision by moving in one of the proposed directions (KUMMER, 1971). This visual procedure works in such an open environment. In Tāi, clear messages about travel direction and speed seem to be necessary and can only be acoustic.

In sum, as a result of the combined effects of 3 ecological factors, low visibility habitat, high predation pressure and a continuously distributed food supply, and 2 socio-psychological ones, large number of adult males in the community and cognitive capacities of the receptor, Tāi chimpanzees have adopted a symbolic-like communication system to reperseve community cohesion. Why has such a system not been observed in other chimpanzee studies? Of the 5 preconditions identified as important in Tāi, none of the ecological factors are fulfilled at the two Tanzanian sites, Gombe Stream and Mahale Mountains. In addition, East African chimpanzees have a lower group cohesion; in Gombe, the mean foraging party size is 4.83 individuals with only 18% of all parties including 7 or more chimpanzees (GOODALL, 1968), whereas in Tāi, the mean foraging party size is 10.28 with 50% of them including at least 7 individuals (BOESCH & BOESCH, 1989). Why do Tāi chimpanzees maintain greater community cohesion than those living in a more open habitat? Two factors may be responsible; predation and territoriality. The observation that some adult chimpanzees in Tāi bear injuries inflicted by leopards are the only such observations known so far (BOESCH, in press). In addition, initial comparisons between the Gombe and Tāi populations revealed that the inter-community encounter rate at Tāi is about 4 times larger than at Gombe (BOESCH & BOESCH, 1989).

Current theories of human evolution state that the transition from a closed environment (forest) to a more open one (savanna) (ISAAC, 1978; Johanson & Edey, 1981; LEAKEY, 1981) is thought to have been the critical event leading to the evolution of «humanlike» characteristics including bipedalism, brain enlargement, cooperation, food-sharing and home base, which was then followed by the acquisition of symbolic language (DAVIDSON & NOBLE, 1989). If comparisons with our closest living relative can shed some light on the evolution of man, two possibilities present themselves. Either some or all of

these «humanlike» traits were not prerequisites for the evolution of symbolism, and this process began earlier, in a closed environment, possibly before the divergence of human and chimpanzee lineage (see BRICKERTON, 1987 for similar conclusions from linguistic studies). The alternative is that even in an open environment, proto-humans may have had a strong need for group cohesion, partly due to high predation pressures (2nd ecological condition). In addition, to be able to forage widely during the day to meet their nutritional requirements (equivalent to the 1st ecological condition) and to reunite subsequently in areas rich in suitable night shelters (caves or trees) (3rd ecological condition) may have required the development in proto-human communities, as in Tāi chimpanzees, of a symbolic communication system. The two socio-psychological conditions seem to be commonly agreed upon in the scenario of human evolution.

It was suggested (BATES *et al.*, 1979) that once imitation, tool use and communicative intent had reached a certain threshold, symbol use inevitably and spontaneously emerged. Brutus's cessation of symbol-like use suggests that, at least in chimpanzees, some additional ecological and sociological conditions have to be satisfied for this emergence to be both inevitable and spontaneous.

ACKNOWLEDGEMENTS — Hedwige Boesch and I thank the «Ministère de la Recherches Scientifiques» and the «Ministère des Eaux et Forêts» of the Ivory Coast for accepting this project and the Swiss National Science Foundation for financing it. The project is part of the UNESCO project Tāi-MAB under the supervision of Dr. Henri Dosso. We are grateful to I. Berthoud, M. Cords, A. Etienne, R. Hinde, A. Sinclair and L. Fishpool for critical reading of the manuscript, A. Aeschlimann, F. Bourlière and H. Kummer for their constant encouraging support, and the director of the Centre Suisse and the staff of the Station IET in Tāi for logistic support.

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Received: 12 May 1990. Accepted: 10 July 1990.