Capuchin Monkey (Cebus apella) Vocalizations in Response to Loud Explosive Noises

Authors: de Resende, Briseida Dôgo, Oliveira, Dilmar A. G., da Silva, Eduardo D. Ramos, and Ottoni, Eduardo B.

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Short Articles

Capuchin Monkey (*Cebus apella*) Vocalizations in Response to Loud Explosive Noises

Briseida Dôgo de Resende
Dilmar A. G. Oliveira
Eduardo D. Ramos da Silva
Eduardo B. Ottoni

Introduction

Primates emit different kinds of vocalizations in different contexts (Struhsaker, 1967; Snowdon and Pola, 1978; Seyfarth *et al.*, 1980; Robinson, 1982; Boinski *et al.*, 1999; Oliveira and Ades, 1998; Maccowan *et al.*, 2001; Di Bitetti, 2001, 2003). For example, long calls can serve as localization cues for conspecifics and are often produced in the context of territorial encounters, mate attraction, and isolation/group cohesion (Waser, 1982; Miller and Ghanzanfar, 2002). Vocalizations used in close-range social interactions may be given in many different situations, such as resting, grooming, foraging or playing (Seyfarth, 1988). Some primates have different alarm calls for different predators (Struhsaker, 1967; Fichtel and Hammerschmidt, 2002; Fichtel and Kappeler, 2002). An often-cited example is the alarm repertoire of vervet monkeys. In this system, receivers respond differently to different calls: for example, they look up and move down or into cover just after an eagle alarm call, and they run into the trees just after a leopard call (Struhsaker, 1967; Seyfarth *et al.*, 1980). The appropriate response contingent upon danger increases chances for survival and reproduction, thus, improvement in fitness. Vervet alarm call specificity improves with age: at first, infants do not show much discrimination among predator classes (they may give eagle calls for non-raptors, for example); then, they give alarm calls for raptors that are not their predators; and finally they learn to vocalize only for the correct raptor predator (Seyfarth and Cheney, 1986; Seyfarth, 1988). Nevertheless, it is difficult to separate the role of genetics and environment affecting development (Seyfarth and Cheney, 1986; Seyfarth, 1988).

Tufted capuchins (*Cebus apella*) were studied by Robinson (1982) and, more recently, by Boinski *et al.* (1999) and Di Bitetti (2001, 2003). Di Bitetti (pers. comm.), studying wild *Cebus nigritus* from Iguazu, Argentina, recorded what he called the "wah wah wah": a vocalization produced by only the adult or subadult males, usually in response to a sudden loud and low frequency sound. The "wah wah wah" vocalization has a duration of 2–3 sec and consists of a repetitive series of 16–22 broad band sounds which contain some tonal components. Di Bitetti reported that males would usually stop doing the activity they were engaged in, and look alert and attentive while vocalizing in response to a loud, explosive sound. The two most common sounds Di Bitetti reported as eliciting this vocalization were thunder and falling branches or falling trees.

Preliminary observations
In our studies of both captive and wild capuchins, we also noted the "wah wah" or "rumble call" vocalization. In May and June 1998, BDR worked with a group of four captive capuchins (two adult males, two adult females) from Quinzinho de Barros Zoo, Sorocaba, São Paulo, Brazil, and she noticed that they emitted a particular vocalization just after explosions coming from a nearby quarry, and that the monkeys approached their cage mates after the explosions. Later that year, in August and September, she also noticed that four captive monkeys from Catanduva's Grove, Catanduva, São Paulo, Brazil, emitted what seemed to be the same vocalization just after firecracker explosions.

After we observed these vocalizations in various populations, we decided to study them in more detail, including the acoustic properties, contexts of emission and associated behaviors, to test our hypothesis that loud and sudden explosive noises are the proximate causes of this vocalization. In this paper, we report all the occurrences of the "rumble call" given by semifree-ranging capuchins of Tietê Ecological Park (TEP), and wild capuchins from Carlos Botelho State Park (CBSP) and Jaraguá State Park (JSP), all in the state of São Paulo, Brazil. For a description of the parks and the capuchin groups, see: TEP–Ottoni and Mannu, (2001); CBSP–Izar (2004); and JSP–Izar *et al.* (in prep.). We also describe a field experiment with a group of approximately 50 free-ranging monkeys in a 7 ha forest fragment in Florínea, São Paulo, to test the ability to elicit the "rumble call" vocalization by producing loud sudden noises. This fragment is surrounded by a sugar cane plantation and has a road running through it. We performed the experiment at this field site because staff from the other parks did not permit shooting fireworks, and because observations of the monkeys were easier in the forest fragment. We did not recognize individuals in this group.

Methods

Field observations
Monkeys from TEP were followed from March 2000 to April 2004 by BDR and Michele Verderane, for a total of 3500 hours of observation. Monkeys from CBSP were followed from November 2001 to December 2002 by Patrícia Izar, for a total of 1032 hours of observation, and monkeys from JSP were followed from January 2004 to July 2004 by EDRS, for a total of 485 hours of observation. All occurrences of these calls were collected in each site, and, whenever possible, we registered the precipitating sound (e.g.: thunder, firecracker, explosion), which individual emitted the call, and other behaviors that coincided with the vocalization. One limitation to the study was that there was only one researcher working at each site at a given time, and a single individual is unable to monitor all the group members simultaneously.

Field experiment
In order to generate more controlled observations of the behaviors and contexts involved in the rumble calls, we performed the following experiment with a group of free-ranging monkeys in Florínea. A total of eight firecrackers were shot into the air, with a minimum interval of 30 min between each shot. Two shots were executed on 20 June 2004, at 17:00 and 17:30; and six on 21 June 2004, from 07:00 to 11:00. To record the vocalizations, we used a Sennheiser ME-67™ microphone and a Sony TCD-D8™ DAT recorder. Recordings started 5 min before each shot and ceased 5 min after it. Whenever possible, the number of monkeys visible during the shots was registered, as well as their age class and the behaviors they displayed immediately after the explosions. However, it was not possible to register how many monkeys vocalized each time, or where all of them looked, or the behavior of every visible monkey.

We converted the audio recordings into wave files in an AMD Athlon XP™ computer with a Philips PSC-706™ soundcard and analyzed them with the Avisoft SASLab Pro™ software. We generated sonograms with a 22 kHz sampling rate and measured time and frequency parameters of calls.

Results

Field observations
Table 1 summarizes the frequency of rumble call events in capuchin monkey groups from three parks in São Paulo. In most observations, multiple individuals gave the rumble call and some group members were observed looking at each other, or running towards each other, giving the impression that they were looking for social contact. Capuchins never emitted this vocalization when there was no precipitating loud sudden noise. However, on some occasions when we were traveling with the monkeys, we heard thunder or other explosions but the monkeys did not respond with rumble calls. In these cases, the explosions tended to be quieter and more distant.

Table1. Frequencies of contexts of capuchin monkey rumble call events in three parks in São Paulo, Brazil. TEP = Tietê Ecological Park; JSP = Jaraguá State Park; CBSP = Carlos Botelho State Park. *Possible causes for rumble calls classified as unidentified in JSP include trucks passing by and objects falling to the ground. Each event that resulted in rumble calls is counted as one observation. Each observation may include vocalizations by several monkeys.

	TEP	JSP	CBSP
Thunder	12	3	7
Firecrackers	23	3	1
Quarry Explosions	0	9	0
Low-Flying Plane	0	0	1
Unidentified	3	19*	0
Total	38	34	9

Field experiment
In all of the eight cases in which we experimentally fired shots, the capuchin monkeys emitted rumble calls immediately after the shots. Capuchins in the sugar cane plantation or in the road ran towards the forest immediately after the shots and vocalized only after they had entered the forest. Both adults (males and females) and juveniles emitted the vocalization. It was not possible to determine if infants vocalized. Rumble calls (Fig. 1) occur as series of harsh pulses, with each pulse lasting about 100 to 120 ms. They reach 7–10 kHz, but the energy is concentrated between 0,9 – 3 kHz. They form quick trails of pulses (up to 15/second), with emissions lasting from 10 to 20 seconds after each firecracker was shot. The most intense calls took place immediately after the firecrackers exploded, with the vocalizations dampened by the noise of the firecracker. This fact, and the occurrence of simultaneous emissions by several individuals, complicates sound analysis. On 21 June 2004, while we were waiting 30 minutes between a shot and the next one, a vehicle with a damaged exhaust pipe passed along the road and emitted explosive noises that also elicited the monkeys' rumble calls.

Discussion

The rumble call is contingent on thunder, skyrockets, explosions or other explosive noises. Both juveniles and adults make the rumble vocalization. At the moment, we cannot determine the role of learning in the development of the rumble call, but it probably has a strong innate component, as the same vocalization was heard in different and distant populations, always contingent upon the same type of external stimulus (Argentina: Di Bitetti; Suriname: Boinski; Northeast and Southeast of Brazil: Izar, Resende, Verderane and Ramos da Silva). For example, Patrícia Izar reported that similar rumble calls were emitted on two occasions immediately after thunder by members of a group of *Cebus libidinosus* from Gilbués, Piauí, Brazil in the course of 42 hours of contact time (Patrícia Izar, pers. comm.).

Apparently, the sound is a stimulus that elicits the monkey's vocalizations. The signaler and the receivers fled from unprotected sites. If it is an adaptive behavior, with an innate component, we wonder what kind of fitness benefit it could provide. As the calls were mainly emitted in response to explosive noises, and as we have registered that monkeys ran to the trees just after listening them, we could hypothesize this vocalization is a sort of alarm call, impelling the monkeys to protect themselves, possibly from a thunderstorm, or from a tree falling. However, according to Di Bitetti (pers. comm.), the acoustic structure of the rumble call is not ideal for long-distance communication, and it does not seem to have any acoustic similarity to other spacing calls, which seem to be related to each other. As Seyfarth (1988) states, there is a direct relation between the function of a call and its

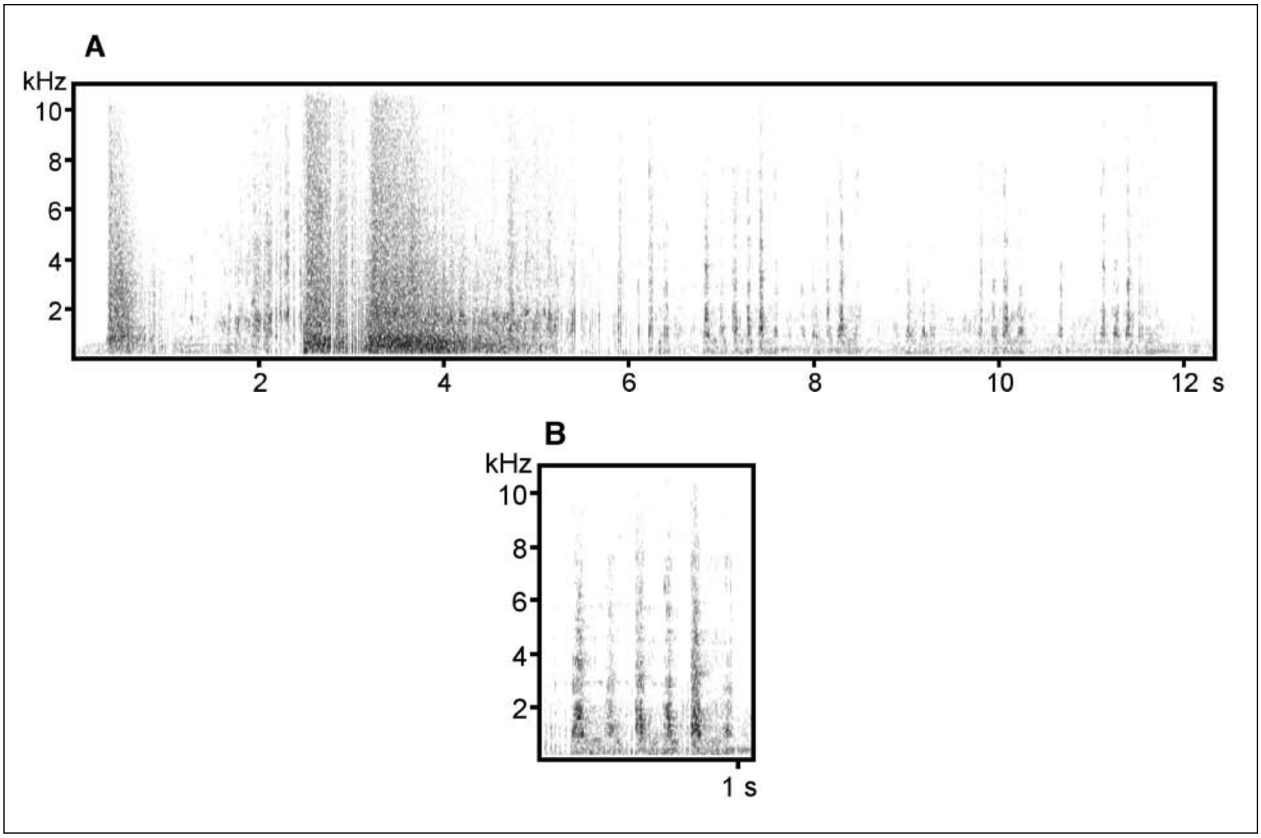

Figure 1. Sonograms depicting the noise stimuli and elicited vocalizations. A) An experimental session with skyrocket rumbles visible as most intense (darker) and longer sounds at approximately 0.3, 2.5 and 3.1 s. Rumble calls are more clearly visible after rumbles, as trails of pulses. B) An amplified section of the first sonogram, showing six calling pulses.

acoustic properties: a call that cannot be heard by subjects far from the signaler cannot be considered an alarm call. For Di Bitetti, the rumble call is a vocalization, produced mostly by adult or sub-adult males, that serves to mediate social relationships among them, and has no relationship with the cohesion-spacing vocal system or the alarm call system. In 16% of his records, this vocalization was produced in social contexts, mostly during reunion displays, without any previous explosive sound. That is why he believes it may function as an appeasement call; this could explain its occurrence during tense situations. The fact that we also scored female vocalizations indicates that, even if it is related to social mediation, this behavior is not exclusively male.

In conclusion, we know that loud explosive noises elicit this vocalization, and that it is similar across populations from different and distant parts of São Paulo State. Juveniles, males and females give rumble calls. As far as we know, non-tufted *Cebus* do not exhibit any rumble calls in response to explosive noises. The biological function of the rumble call and its ontogeny are interesting puzzles that demand more elaborate experimental designs. These experiments should focus on individual observations of subjects from different age and sex classes, scoring their vocal behavior, and the response exhibited just after explosions.

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Briseida Dôgo de Resende, Universidade de São Paulo (USP), e-mail: <briseida@usp.br>, **Dilmar A. G. Oliveira,** CEPESBI / Universidade Regional de Blumenau (FURB), **Eduardo D. Ramos da Silva** and **Eduardo B. Ottoni,** Universidade de São Paulo (USP).

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Extragroup Copulations Among Brown Howler Monkeys in Southern Brazil

Marcos de Souza Fialho
Eleonore Z. F. Setz

Introduction

Like most other howler monkeys, brown howlers (*Alouatta guariba*) form one-male groups with up to 10 individuals. Even if there is more than one adult male, the alpha male howler monkey usually monopolizes all reproductive females and sires all young (Pope, 1990). However, extra-group copulations (EGCs) have been observed in *Alouatta pigra* (Horwich, 1983) and *A. seniculus* (Agoramoorthy and Hsu, 2000). Here we report the first EGCs observed in *A. guariba clamitans.*

Methods

We studied brown howler troops in hillside forest in Porto Alegre (30º12'S, 51º04'W), Brazil, during the summer (Nov 1998 – Jan 1999, 483 obs. hours) and winter (Jun – Aug 1999, 386 obs. hours; Fialho and Setz, 2000). Study group GA was comprised of three adult males, three adult females, and four immatures. An adult male had emigrated from this group in October 1999 (MMA Jardim, pers. comm.). A neighboring group (GB) had five individuals. The GB alpha male was larger and had a more intense reddish coloration than any GA adult male.

Results

Daily inter-group encounters between the study groups were accompanied by extended vocalizations, but they were usually peaceful. However, an aggressive encounter between GA and GB occurred on June 12. During this encounter, the GA group chased and bit individuals from GB, and one GB individual fled to the ground. Only the GB alpha male was not attacked. Shortly after this aggressive encounter, the GB alpha male copulated with a GA female, just a few meters away from other GA group members. The observing males of GA group did not react. On June 13, the same two individuals performed two more EGCs. In the morning, the male inspected the female's genitalia twice and copulated with her; an hour and a half later, the large GB male was feeding in a *Ficus* tree where GA group was resting. The GB male approached their group more closely, and GA group members became agitated. The GB alpha male vocalized within a few meters of the group, and the female left her group and followed him for about 50 meters. The female produced nasal sounds ("Hummm, hummm"), while flick-