

CEBUS PARAGUAYANUS IN ZOOS: THE SPONTANEOUS EXPRESSION OF SPECIES-SPECIFIC BEHAVIORS

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Abstract

Captive *Cebus paraguayanus* were observed to express spontaneously a wide variety of species-specific behaviors in different zoos from Argentina. The monkeys were kept in old-style wire mesh cages with cement floors, as well as island enclosures. We collected qualitative data on nine species-specific behaviors, and all the sex-age classes analyzed expressed some of these behaviors. The results indicated that in spite of living under predictable captive conditions without environmental enrichment, *Cebus paraguayanus* were able to react to the incidental opportunities that were presented in these environments.

Key words: *Cebus paraguayanus*, captivity, natural behavior, zoos

Resumen

Cebus paraguayanus alojados en zoológicos de Argentina, expresaron de manera espontánea una amplia variedad de conductas especie-específicas. Los ejemplares estaban alojados en recintos de exhibición tradicionales, con suelo de cemento y alambrado perimetral, inclusive en una isla. Se observaron nueve conductas especie-específicas y todas las clases sexo-etarias expresaron algunos de ellos. Los resultados indican que a pesar de ocupar ambientes altamente predecibles y monótonos, *Cebus paraguayanus* fue capaz de reaccionar de manera natural hacia oportunidades que brindaban los recintos de exhibición donde se alojaban.

Palabras clave: *Cebus paraguayanus*, cautiverio, conductas naturales, zoológicos

Introduction

Capuchin monkeys, genus *Cebus* (Platyrrhini: Cebidae), are omnivorous primates with a diet consisting mainly of fruit, and in lesser quantity, insects and other plant parts (Freese and Oppenheimer, 1981). Terborgh (1983) has pointed out that capuchins use a destructive feeding strategy; by means of their strength, they can exploit food resources not available to other animals. Both in natural and captive conditions, capuchin monkeys use a wide variety of manipulative skills. They have been observed to crack open hard-shelled fruit (i.e.: Izawa and Mizuno, 1977; Izawa, 1979), hunt different vertebrates and invertebrates (i.e.: Isawa, 1979; Robinson and Janson, 1987; Rose, 1997; Ferreira *et al.*, 2002), use tools like stones and branches (i.e.: Anderson, 1990; Visalberghi, 1990; Ottoni and Mannu, 2001; Fragaszy *et al.*, 2004a; Moura and Lee, 2004), tap scan for presence of hidden animals (Isawa, 1978; Phillips *et al.*, 2003), and fur rub with different plant and animal materials (Baker, 1996; Gilbert *et al.*, 1998).

Cebus paraguayanus (also called *Cebus apella paraguayanus* Fisher, 1829, or *Cebus libidinosus paraguayanus*) finds its southern limit of distribution in Argentina (Mudry, 1990; Martinez *et al.*, 2002). Its natural habitat is shrinking and, in addition, commercial traffic is affecting its populations (Giudice and Mudry, 1995), and is increasing their vulnerability to local extirpation (Diaz and Ojeda, 2000). In Argentina, *C. paraguayanus* is one of the Neotropical primates most frequently found in zoos (Giudice, 2000). Zoos in Argentina can be defined as "old-style zoos," following Crockett (1998), with conditions that lack furnishings and bedding materials. Here we use "old style" zoos to refer to zoos that have enclosures of either old or modern architecture but that lack the physical, biological and social stimuli necessary to favor the acclimatization of the animals. These zoos often practice highly deficient management procedures. In extremely predictable enclosures, with little environmental complexity, animals find it difficult to move freely, are unable to choose when and what to eat, with whom to associate with, where to sleep and where to shel-

ter. Under these circumstances, behavioral problems arise and it seems unlikely that a normal range of species-specific behaviors will be expressed (IPS, 1993; Mateos Montero, 1994).

While several studies of capuchin monkeys have been conducted in research laboratories (i.e.: Visalberghi and Trinca, 1989; Visalberghi and Fragaszy, 1995; de Waal, 2000; Brosnan and de Waal, 2003), there is limited published information about capuchin behavior in zoos. Observations of species-specific behaviors recorded for *Cebus* in zoos are mostly anecdotal (*C. olivaceus*: Urbani, 1999; *C. apella*: Mendes *et al.*, 2000; Urbani and Urquiza-Haas, 2002). The groups of *C. paraguayanus* studied here in the "old-style zoos" from Argentina were made up of monkeys that were: a) illegally captured and then confiscated, b) pets highly habituated to humans, c) obtained from institutional exchange or d) born in zoos. Our study aim was to examine to what extent captive *C. paraguayanus* express species-specific non-social behaviors. This study clarifies how *C. paraguayanus* behave in the captive conditions of old-style zoos, and it gives insight into the degree of behavioral plasticity found in this Neotropical primate in an environment with no human-directed enrichment protocol.

Materials and Methods

Study sites, subjects and husbandry

Data were collected in four zoos from Argentina: Jardín Zoológico de Buenos Aires (JZBA), Jardín Zoológico de La Plata (JZLP), Estación de Cría de Animales Silvestres de Berazategui, Buenos Aires province (ECAS), and Estación Zoológica Experimental de Santa Fe (EZE). The enclosures, constructed for public viewing, varied in size from 34 m³ to 127 m³. They contained wire-meshed walls and roofs, soil or cement floors, indoor and outdoor rooms, crossbars, ropes, platforms, dry tree trunks, and some refuges. We also present data from a 100 m² island enclosure at JZBA. The composition of the groups of *C. paraguayanus* in each zoo is summarized in Table 1.

The monkeys were fed once a day around 09:00 with vegetables, fleshy fruit, bird eggs, and, except at EZE, meat and bread. Both food and water were placed on trays on the floor. None of the groups observed were presented with any routines of environmental enrichment.

Table 1. Sex-age classes of the studied colonies of *Cebus paraguayanus*.

Zoos	Adult males	Adult females	Juveniles	Infants	Total
JZBA	6	5	6	2	19
JZLP	5	3	-	-	8
ECAS	1	7	4	-	12
EZE	5	3	4	-	12
Total	17	18	14	2	51

Behavioral observations

The observations were collected between 1994 and 2002 during the course of other studies by AMG (1994–1998, see Giudice, 2000), and RP (1994/2002, see Pavé, 2003). The total observation time was 1232 hours (Table 2). Research projects had similar study goals, and in all the observation periods, scan and *ad libitum* sampling were used (Altmann, 1974) in 30 minute blocks. Data were collected between 9:00 and 19:00.

In this study, nine species-specific behaviors (as defined in Table 3) are described and analyzed qualitatively. For hunting activity, we were able to obtain hourly occurrence rates across all the study periods, and we calculated these as the frequency of the hunting events divided by the total observation time per group.

Results

Hunting behavior

We estimated an hourly frequency of hunting behavior at the different zoos: 0.85 events per hour at JZBA (n = 164 events), 0.56 events per hour at ECAS (n = 206 events), 0.52 events per hour at JZLP (n = 130 events), and 0.40 events per hour at EZE (n = 109 events). Note that these frequencies do not take group size into account. More than 98% of hunting activity was directed toward invertebrates, mainly flies. Adults and juveniles of each sex hunted flying insects and even a three-month old infant was observed in hunting attempts. In the JZBA cage enclosure, an adult female hunted and consumed a house sparrow (*Passer domesticus*). At ECAS, an adult female hunted a rufous hornero (*Furnarius rufus*). Also at ECAS, the final phase of hunting a duck (Fam. Anatidae) was observed. The duck was grabbed through the wire mesh, and while the duck body remained outside the cage, each capuchin approached the prey, took a piece of it and ate its share away from other individuals. At EZE, the capture of a hornero (*Furnarius* sp.) was also observed; the bird got into one of the enclosures and was immediately chased by the alpha male of the group until it was captured through the wire mesh. The monkey killed the bird by biting its head and then ate parts of the head and carcass, which he also shared with an adult and two juvenile males in the group. At the JZBA cages, an adult male scattered food outside of the enclosure, apparently in order to attract pigeons (*Columba livia*) for capture

Table 2. Study periods in four zoos of Argentina.

Study sites and lodging conditions	Study periods	Observation hours
JZBA (Cages)	1994–1995	192
JZBA (Island)	1995–1996	50
ECAS (Cages)	1995–1997	366
JZLP (Cages)	1996	250
JZLP (Cages)	1998	100
EZE (Cages)	1999, 2002	274

when they came close enough to reach through the wire mesh. In addition, a juvenile male unsuccessfully hunted a kitten. The small cat was handled and pressed against the mesh, as the juvenile tried to pull it into the enclosure. At JZBA island, an adult female handled an approximately 20 cm long aquatic turtle (*Trachemys* sp.); she repeatedly hit the turtle against the floor, examined it, bit it, and finally lost interest and left it.

Tool use

Capuchins were able to attain food out of their reach by using sticks, and occasionally, leaves and petioles that they stuck through the mesh wire. At EZE, an adult female took a stick from the adjoining cage, broke it up in two pieces and used one of them to acquire a piece of meat from that cage. The same monkey also used dry leaves that she had removed from her cage roof to try to acquire meat from the adjoining cage as well as a peanut from outside the cage (note that at EZE the monkeys did not receive meat or peanuts in their diet). Similarly, at ECAS, an adult male and female used branches to reach a slice of bread and grapes that were outside the cage and out of their reach. At ECAS and EZE, sticks and leaves were used to explore the soil or the grass growing outside the enclosures. Monkeys used sticks to dig in the ground and at the bark of dry trunks, to explore the holes of trunks or the wall, and to explore the water depth in the pond at the JZBA island. In the JZBA cages, an adult female was observed to use a little piece of straw from a broom to remove splinters from her hand.

Capuchins also used objects to kill animals. At EZE, an adult male killed a 25 cm long non-venomous snake by using the brim of a metal container. This monkey struck the

brim of the container several times over the snake's head; then he bit the head and continued eating the rest of the snake. Other types of tool use included striking two objects against one another. At EZE, an adult male used sticks and stones to crack open fruit of the Pindó palm (*Syagrus* sp.). At JZBA, this activity took place at preferential locations in two cages: the objects were placed in a deep-set square metallic grate, which was used as an anvil. At EZE on two occasions monkeys used sticks like a lever to separate the wire mesh wall from the cage floor.

Foraging

This activity includes the handling and consumption of plant resources accessible from the enclosure. At EZE, monkeys consumed bermuda grass (*Cynodon dactylon*), which grew outside the front of the enclosures and, in some cases, the capuchins consumed leaves and twigs either with or without buds of poplar (*Populus deltoides*), plane tree (*Platanus acerifolia*), and tipu tree (*Tipuana tipu*). A tala tree (*Celtis tala*) next to one of the enclosures at ECAS had branches overhanging the cage roof that were not accessible to the monkeys. In autumn, monkeys were seen eating fruit from this tree when it fell into the enclosure. In one cage at JZBA in the early spring, some foliage from an ombu tree (*Phytolacca dioica*) fell on the roof of the enclosure, and monkeys consumed the inflorescences. Once, keepers at EZE put some soil outside the cages and near the wire mesh, and adults and juveniles consumed grass leaves and roots present in the new soil.

Manipulative events

A frequent observation was that the capuchins hit apples, potatoes, walnuts, or almonds several times against some

Table 3. *Cebus paraguayanus* behaviors recorded in the study.

Behavioral units	Definition
Hunting behavior	To obtain animal products by means of an active search process; prey is caught with the hunter's limbs and mouth and immediately consumed.
Tool use	To use an unattached environmental object to alter more efficiently the form, position or condition of another object, another organism or the user itself (Beck, 1980). A tool is employed as a functional extension of the animal's body to bridge between itself and its target (Visalberghi, 1990).
Foraging	To direct behavior toward a potential food source not included in the zoo diet. Actions include directed search, processing and consuming (Fragaszy, 1990).
Manipulative events	To use hands and mouth to alter the form, position or condition of another object, which involved two or more coordinated acts. For example, digging in the ground as a necessary step toward acquiring a hidden piece of food was registered as a manipulative event, but picking up a piece of food lying on the ground was not (Jalles-Filho, 1995).
Tap scanning	To give soft hits to a surface with the fingertips of one hand. Tapping lightly and rapidly (Phillips <i>et al.</i> , 2003).
Fur rubbing	To apply a foreign substance over the body pelage using hands, feet and tail, in a highly energetic way (Baker, 1996).
Drinking behavior	To introduce hand and arm in the water source, soak their hairs and then lick the water that drains off the arm or hand. Dipping-and-licking technique (Wrangham, 1981).
Behavioral thermoregulation	To rest keeping arms and legs flexed and close to the body while the back is bent, to conserve the heat during periods of low ambient temperature (curled posture). And to rest extending the back and all members, to dissipate heat under hot conditions (stretched posture) (Bicca-Marques and Calegari-Marques, 1998).
Vertical flight response	To climb suddenly to the enclosure roof and to remain expectant (Giudice, 2000). In the wild, capuchins react to aerial predators moving upwards in the trees and scanning (Rose <i>et al.</i> , 2003).

hard surface, like the floor or the mesh, in order to eat the bits stuck to the surface or to the food. At EZE, another common food processing strategy was that adult and juvenile males rubbed dry leaves, grass, small sticks, food, or other items between their hands or against the enclosure floor.

Tap scanning

This activity is used by the capuchins in natural conditions to detect the presence of vertebrates or invertebrates hidden inside tree trunks. At EZE three adults and one juvenile were observed to tap scan on a dry tree trunk several times. They were also observed to tap scan on some sticks. In some cases, after tap scanning, they bit the tree bark. Also, these animals explored the holes of dry trunks with their fingers and in some cases, they employed a technique observed in natural conditions; they ripped up the bark of the tree with their mouths and hands and then licked the surface.

Fur rubbing

At EZE, an adult male took some water with bleach from the recently washed drinking dish and used his hand to rub it over his back. On another occasion, an adult male smelled the enclosure floor, rubbed his cheek on the same place, and then was imitated by one of the juveniles. At JZLP, two adult males were observed to rub onion over their bodies.

Drinking behavior

At ECAS a keeper left a bucket with water outside the enclosure, next to the mesh. The monkeys could not reach the bucket with their mouths, but they introduced their hands into the water, and then drank the water dripping from their arms.

Behavioral thermoregulation

In each of the zoos, energy-conserving or energy-dissipating postures were observed. In winter, animals rested using the curled posture in the sunny places of the enclosure. In summer, monkeys adopted the stretched posture leaning their ventral region on the floor or on thick crossbars, especially in shady places. These behaviors were observed in all the sex-age classes studied.

Vertical flight response

At EZE, in response to calls emitted by a group member or by monkeys from adjoining cages, the capuchin group would suddenly climb to the upper part of the enclosure, or run into the indoor room. They also reacted daily in this way in response to the presence of a zookeeper near the enclosures. This vertical flight response was observed upon detection of southern crested caracaras (*Polyborus plancus*) flying overhead, after vocalizations emitted by dogs and captive flamingos (*Phoenicopterus* sp.), and on two occasions in response to spider monkeys (*Ateles paniscus*) emitting loud vocalizations in adjoining cages. At ECAS vertical flight behavior was observed at least once a day. A call made by a capuchin group member was the most frequent

stimulus that triggered this response. The individual that made the call would climb rapidly up the mesh wire to the cage roof, and this behavior was immediately imitated by other group members. In all cases, after a few seconds on the roof or in the indoor room, the monkeys returned to the floor.

Discussion

In the four study populations of *C. paraguayanus* kept in old-style zoo enclosures, we observed the normal expression of nine species-specific behaviors, and all the sex-age classes analyzed expressed at least some of these behaviors. Monkeys hunted flying insects and different vertebrates, mainly birds. The hunting of invertebrates and vertebrates has been recorded often in capuchin monkeys in natural and semi-free ranging conditions (Isawa, 1979; Freese and Oppenheimer, 1981; Janson, 1985; Brown *et al.*, 1986; Robinson and Janson, 1987; Rose, 1997; Ferreira *et al.*, 2002; Sampaio and Ferrari, 2005). In one case, in our study an adult male scattered food outside the cage, apparently to attract pigeons as potential prey. This may suggest a certain cognitive ability, and is in line with similar observations in other captive capuchins, documented to attract ducklings and fishes (McGrew and Marchant, 1997; Mendes *et al.*, 2000). This observation also highlights the ability of capuchins to take great advantage of the opportunities that are presented in the zoos and to develop alternative foraging strategies to meet them.

Tool use was observed in a variety of contexts. Branches and leaves were spontaneously used like arm extensions to obtain food that was out of reach, or to explore distant or hidden surfaces. As observed in wild *Cebus* (Moura and Lee, 2004), individuals in this study used objects to dig in the ground. An adult female used a small piece of straw from a broom to remove splinters from her hand. Monkeys also cracked fruits with sticks and stones using the same actions as described by Izawa and Mizuno (1977). An adult male used the brim of a metal container to kill a non-venomous snake. Although Boinski (1988) reported the use of a branch by wild *Cebus capucinus* to attack a venomous snake, the case observed here with a potential prey item can be considered a prey processing technique equivalent to the use of objects as hammers to crack open oysters (see Fernandez, 1991), and to the cases described above with fruits and reported in wild *Cebus* (i.e.: Izawa and Mizuno, 1977; Anderson, 1990; Moura and Lee, 2004). Our monkeys often hit different foods against hard surfaces and then ate the bits; this food processing technique has been observed in captive (Urbani and Urquiza-Hass, 2002) and wild *Cebus* (Moura and Lee, 2004). In one zoo (JZBA), individuals used a square metallic grate as an anvil to facilitate the cracking open of fruits. This anvil technique has been reported in several *Cebus* studies (i.e.: Ottoni and Mannu, 2001; Fragaszy *et al.*, 2004a). Perhaps the most interesting tool use was by an adult female, who took a stick from the adjoining cage, broke it up in two pieces, and used one of

them to obtain meat from that cage. The sequence is interesting for various reasons. First, it shows the ability of capuchins to solve problems. It also shows the capacity of the female to modify the stick before using it like a tool. Similar actions have been documented in *Cebus apella libidinosus* (Moura and Lee, 2004) and *Pan troglodytes* (Boesch and Boesch, 1990; Pruettz and Bertolani, 2007).

Captive capuchins employed tap-scanning to detect the presence of hidden animals inside trunks and sticks. They used their fingers to explore inside holes of different substrates and in some occasions they ripped up bark to obtain something or just to lick the surface. All these species-specific behaviors show that capuchins continue to use sensory cues to guide their search for prey and display the manual dexterity and extractive foraging characteristic of capuchin monkeys (Izawa, 1978, 1979; Phillips *et al.*, 2003), even when in captive conditions with minimal enrichment. The captive monkeys displayed fur rubbing and dipping and licking behaviors. Monkeys in this study fur rubbed with a water-bleach solution and with onion over their bodies. Fur rubbing using several plant and animal materials has been observed in wild and captive *Cebus* (Baker, 1996; Gilbert *et al.*, 1998), and it has also been reported in owl monkeys, *Aotus* (Zito *et al.*, 2003). Dipping and licking behavior allows for access to drinking water even when it cannot be directly obtained by the mouth, and it has been observed in Old World Primates (*Cercopithecus aethiops*: Wrangham, 1981; *Procolobus badius temminckii*: Starin, 2002) as well as in wild and captive Neotropical primates (*Cebus capucinus*: Freese, 1978; *C. olivaceus*: Urbani, 1999; *Alouatta caraya*: Bicca-Marques, 1992; Giudice and Mudry, 2000; *Saimiri* sp.: Baldwin and Baldwin, 1981). In primates behavioral thermoregulation is important to conserve heat during cold periods and to dissipate heat in hot periods (Bicca-Marques and Calegario-Marques, 1998). In winter, animals rested huddling in sunny places using the curled posture. In summer, *C. paraguayanus* rested using the stretched posture especially in shady places (Paterson, 1986). These strategies have been observed in wild capuchins (Fragaszy *et al.*, 2004b) and other Neotropical primates (*Alouatta caraya*: Zunino, 1989; Bicca-Marques and Calegario-Marques, 1998; *A. palliata*: Muñoz *et al.*, 2002).

We also observed the vertical flight response in the captive groups. In wild conditions, capuchins produce different alarm calls toward aerial and terrestrial predators and they react differently to each type of call (Fedigan, 1993; Di Bitetti, 2001; Rose *et al.*, 2003). The same antipredator responses were expressed daily by our *C. paraguayanus* groups. They moved upwards or downwards in the cages in response to the detection of caregivers or flying raptors or in response to vocalizations of dogs and flamingos. The only species of raptor that the individuals detected and gave alarm calls for was a southern crested caracara (*Polyborus plancus*). Rose *et al.* (2003) reported that *Cebus capucinus* in Costa Rica often alarm-called for *Polyborus plancus* but they did not observe predation attempts by this raptor.

Interestingly, vertical flight response was observed in capuchins after loud vocalizations emitted by spider monkeys (*Ateles paniscus*) kept in adjoining cages. Other interactions observed between *Cebus* and *Ateles* were initiated by the capuchins and included both affiliation, in the form of gentle touching (n=2 events), and aggression, including tail and limb pulling, chases over the wire mesh, and pinches (n=9 events). Although interactions have been observed between *Cebus capucinus* and *Ateles geoffroyi* in Costa Rica (Rose *et al.*, 2003), this is the first report of *Cebus* responding to *Ateles* alarm calls. Inter-specific responses to alarm calls do exist in other primates (*Saguinus labiatus* / *S. fuscicollis*: Buchanan-Smith, 1990; *Saguinus mystax* / *S. fuscicollis*: Heymann, 1990; *Cercopithecus mitis* / *C. ascanius*: Cords, 1990).

While the present study is about non-social behaviors, two social behaviors observed in the study deserve mention. First, food sharing occurred subsequent to the hunting of a bird (*Furnarius* sp.). This cooperative behavior has been reported in free-ranging conditions for *C. capucinus* (Perry and Rose, 1994; Rose, 1997) and in semi-free-ranging conditions for *C. apella* (Ferreira *et al.*, 2002). In the observed case the hunter, the alpha male, shared part of the prey by allowing other group members to take scraps that fell on the floor. This sort of food transfer is the most common type observed by Rose (1997) and Ferreira *et al.* (2002). Second, the attempt at hunting by a three month old infant may have been a result of local or object enhancement, as the infant had the opportunity to watch adults hunting for the same prey items. As previously noted in other studies of capuchins (Perry and Rose, 1994; Ottoni and Manu, 2001), through the observations of older animals, the infants learn by trial and error to be more proficient at hunting.

Our results confirm the behavioral plasticity of the capuchin monkeys, their flexible foraging strategies, and their ability to explore and manipulate the environment, including through the use of tools. They displayed a high capacity to take advantage of the opportunities that were presented often inadvertently in the highly predictable conditions studied. Taking into consideration that modern zoos should be conservation agents not only of genetic diversity but also of the behavioral diversity (Rabin, 2003), zoos should be encouraged to increase the opportunities to stimulate the expression of species-specific behaviors in capuchin monkeys and other species.

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