# Chapter 15

# Identification and Description of Behaviours and Domination Patterns in Captive Vervet Monkeys (*Cercophitecus Aethiops Pygerythrus*) During Feeding Time

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## Abstract

In the current study we explore dominant behaviours and interactive patterns during feeding of a group of captive vervet monkeys (Cercophitecus aethiops pygerythrus). Observations were carried out in a group including an adult male, an adult female, two immature individuals, and an infant, living in the Guadalajara Zoo. They were located in a confined area that was divided in six zones according to the proximity or distance to where the spectators are located. For the collection of behavioural data we used the Observer 5.0 and Theme 5.0 for detection and analysis of behavioural patterns. Three recordings for every day were made (i.e. Wednesday to Sunday), during feeding time, at approximately 17:30 h and each lasting 1½ h, beginning 30 min before food delivery. We registered general activities (i.e. eating, resting), as well as domination behaviours (i.e. allogrooming, agonism, direct and indirect access to food). Results indicate significant differences in the use of space/proximity between female and male, as well as the proportion of general activities, although resting was the main registered behaviour. Differences by sex (i.e. male, female) and by location of the place of food delivery (i.e. inside, outside) were observed in expressed behaviours and interactive patterns. In wildlife conditions, female hierarchy usually dominates over male hierarchy, possibly because of social networks established between female relatives. However, in captivity conditions the group structure changes, modifying its function (i.e. male predominant over female). The current type of research might provide us with clues on how to improve the design of the facilities for captive animals. Future objectives of the project concern comparing the findings to data collected in the wild and implementing the results into a new design of the facilities for captive vervet monkeys.

**Key words** Vervet monkey, T-patterns, Theme

## 1 Introduction

Because recreational functions are the main objective of most zoos, the enclosures are generally designed so that the visitors can easily see the animals, and thus they are not built in accordance with the animal's natural habitat or the behavioural characteristics of the diverse species on exhibition (e.g. 1). For this reason, emitted

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behaviours will vary in respect to those emitted in wildlife, developing specific types of interaction in captivity (i.e. "artificial" environments), situations created and modified by humans, as in the case of the social structure of the captive animals. For example, Manning [2] suggests, in relation to domination aspects, that unlike what happens in freedom, fights are more frequent in zoos, usually because spaces are reduced and there is not sufficient space for the subordinates to stay far away from the dominant individuals.

Vervet monkeys (*Cercophitecus aethiops pygerythrus*) are old-world primates; they are of a greenish-brownish colour with the chest and contour of the face in white colour. Face, hands, and legs are of black colour [3–5]. The male has, around its genitals, a shining blue colour, contrasting with its penis, which is of red colour [3, 5, 6]. As far as weight, males weigh approximately 6 kg with height 1 m, and females are smaller and usually weigh 4 kg [7].

The natural habitat of vervet monkeys is the semi-desert zones in the African savannah of the Sahara, where there are a great amount of trees; this species is considered semi-terrestrial, because usually they are transferred between zones by ground [5]. Although they feed basically on fruit, flowers, and insects (i.e. leaves, seeds, nuts, different kinds of grass, fruits, berries, eggs), their diet varies according to available resources (e.g. 5, 6, 8). Their predators in wildlife are lions, leopards, cheetahs, and other types of felines, in addition to hyenas and baboons, among others [5, 9, 10].

This species has a matriarchal linear hierarchy, separate from the male hierarchy; in this type of hierarchy, the alpha females (beta, gamma) are supported by their close relatives forming coalitions in order to maintain their hierarchic position. Daughters usually inherit the rank of their mothers and mothers still support their female offspring after the daughters have reached maturity [11]. Females of higher hierarchy and relatives (i.e. mothers, sisters, and daughters), are those who can look for and select more and better quality food [7, 12, 13], thus they have more advantage in comparison with lower hierarchical level individuals, better nutritional reserves, better health, and more opportunities for successful reproduction. Dominant individuals determine access to the food, places of rest, and access to the females (e.g. 2, 13). Also, the dominant one usually receives more allogrooming than other members of the group; this activity, presented frequently in primates, serves them as a pacifier gesture.

As a way to maintain domination in the group, and to communicate the status that the individual has in the hierarchy rank, males usually present ritual displays to show their dominant position, a cheaper energetic way than physical fights; one of the basic domination displays is to exhibit their scrotum that works as a symbol of their power in the troop [7]. There are two different forms of scrotum exhibition, the first known as *splay-legged*, in which the male is sited down on a tree branch or on the floor with its knees

opened, leaving the genitals exposed. This kind of display appears as an aggression sign when a vigilant male detects another male near the limits of his territory, signalling that the intruder not approach either the territory or the female group [14].

A second form of domination display is known as the *red, white, and blue display*, and consists of the approach of the dominant male to a subordinate, walking in circles around him, raising his tail and exposing the genital–anus area to the minor rank male [15, 16]. Other forms to express domination within the group are face gestures or expressions, such as: (a) the exhibition of the eyelid, because the skin of this area is of a shining colour, contrasting with the rest of the face, which is black colored; and (b) retracting the forehead while the dominant individual is fixedly watching the dominated individual [2, 15]. At the same time, to stand up in a bipedal position in the face of the subordinate or to shake its body facing another individual, can work as threat expressions. It has been observed that if the subordinate responds to these expressions, it bends over or crouches, making some grunts.

Another important characteristic of the vervet monkey, which allows them to organize as a group, are their vocalizations, because they have an alarm system that announces to the other members of the group that a predator is close, changing the type of sound according to the identified predator (e.g. 17–19). According to Cheney and Seyfarth [20] the vervet monkey has a great ability to recognize signals emitted by other monkeys and predators in their wild habitat, although they do not seem to have the capacity to generalize in other contexts, as in the case of captivity environments.

From an interbehavioural approach (e.g. 21, 22), Ortiz et al. [1] and Ortiz [27] suggest that when an individual behaves in a specific situation, it is responding to elements and particular events that compose that situation. Such elements have both a physical–chemical nature (i.e. the environmental temperature or colours and scents of certain types of plants and animals), and a quasi-conventional nature (i.e. formation and dynamics of the social group in which it is immersed). In this sense, each species, and each individual of that species, due to its psychological characteristics, keeps a singular relation with the environment and other species. Thus, each species (anatomically and physiologically adapted, as well as behaviourally adjusted to its surroundings), develops specific behavioural modifications both for its survival [23] as well as for the sustainable maintenance of the dynamics of the ecosystem of which it is part.

In this sense, we can identify some elements that can allow us to describe the ecological milieu and analyse its function-related animal behaviour. Ortiz et al. [1] and Ortiz [27] propose that we can, and must, identify geophysical elements (i.e. scents, shapes, flavours, colours, weather, seasonality), geoecological elements (i.e. type of land

or enclosure, location and size of feeding, location and distribution of resting and protection zones), interactive elements (i.e. presence or absence of the same or other species or individuals), as well as the relationship between behaviour and adjustment criteria in a specific situation (i.e. behaviour specific to a situation, related to a situation, functional in a situation). Under this scope, if domination behaviours are psychological ones, they can differ from a captive group to those emitted in wild conditions, because in captivity the context often differs with respect to the wildlife conditions on population density, space in which the group lives, the fact that they do not have to search for food, as well as the composition of the group (i.e. ratio gender).

The present study is focused on identifying and describing domination-related behaviours during feeding circumstances. Although any other circumstance could have been selected, we chose feeding; it was considered pertinent because in captivity there are few circumstances in which animals can be immersed and because it seems to be part of the most relevant events in their day. Also, during feeding time in wildlife, this species emitted behaviours that make reference to domination aspects, where females of higher hierarchy have food access primacy (e.g. 7, 9, 13).

## 2 Methods

### 2.1 Subjects and Enclosure

The observations were carried out in a captive group ($n=5$) of vervet monkeys (*Cercophitecus aethiops pygerythrus*) that lives in the Guadalajara Zoo. The group contained an adult male, adult female, two immature individuals, and an infant. This troop was located in an enclosed area 6 m wide long by 6 m and 1.70 m height, with an unevenness of 3°; the area is delimited by three cement walls and one metallic grate that separates the animals from the spectators; also, the ceiling is constituted of the same material as the grate (see Fig. 1). The floor of the back part of the confinement (2 $m^2$) is covered with cement, whereas the floor of the rest of the confinement is compacted earth (4 $m^2$). In the centre bottom of the confinement, there is access to the dormitory area.

For analysis aims, the confinement was divided in six zones (Fig. 1): far left (FL), far central (FC), far right (FR), close left (CL), close central (CC), and close right (CR) (see Fig. 1).

### 2.2 Materials

A camcorder Sony 8 CCD-TR413 was used to register the behaviour of the subjects for approximately 1½ h during feeding time. In order to make the registration and analysis of the observations, the Observer version 5.0 program was used. Also, for the analysis of sequences of interactions we used the Theme 5.0.

### 2.3 Procedure and Data Analysis

Recordings were carried out from Wednesday to Sunday, covering three recordings per day in three different weeks and Wednesday and Thursday of the fourth week, during March, 2006, obtaining

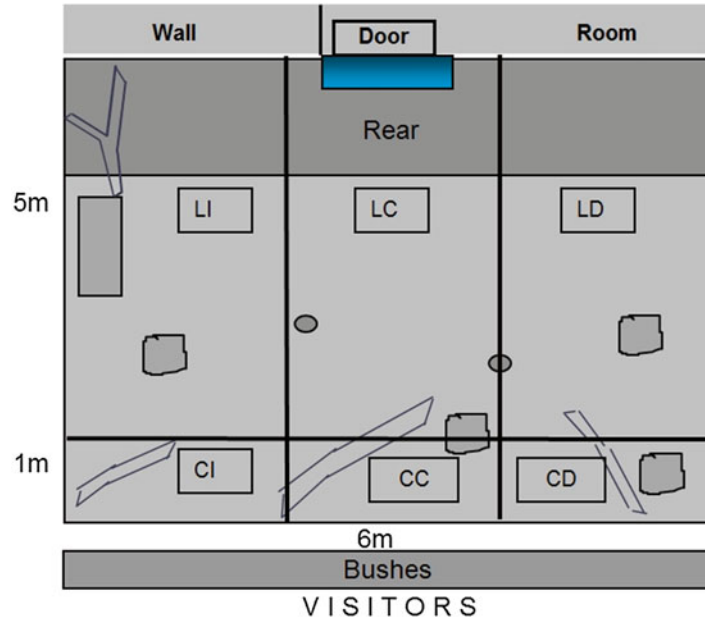


**Fig. 1** The vervet monkeys enclosed area, divided into six zones

a total of 17 videos. The recordings were made when the caretakers fed the subjects, approximately at 17:30 h; each recording lasted 1½ h, initiating 30 min before the food delivery (17:00 h). In order to make the recordings, we placed the camcorder on a tripod, at a distance that allowed us to observe all the confinement areas and all five subjects.

We used an animal focal continuous method of registering [24] based on the behaviour catalogue, using the Observer 5.0. Once the observed behaviours were registered, the obtained data were analysed with Theme version 5.0 obtaining information on temporal sequences of frequent interactions.

Behavioural sequences were analysed as displayed patterns when the food was inside or outside the dormitory area, thus having two conditions of study, with the purpose of making comparisons of the displayed pattern by the subjects in both conditions, considering the change an important element during the feeding circumstance (i.e. the place where feeding behaviour occurs).

Next, we describe both conditions (i.e. inside and outside) in terms of some elements of the proposed methodology by Ortiz et al. [1] and Ortiz [27], such as the ecological milieu, some geophysical and geoecological aspects, and intra- or interindividual interactions:

1. Condition "outside the dormitory": Condition when the food is located in the far central zone (LC) just outside the dormitory

main entrance. The food is put on the ground. To the right side of the food pile there is a stone and on the left side a cement wall. When the food is located outside, all individuals have access to the food, inasmuch as it is in open condition; that is to say, the food is put almost at the centre of the confinement and there are no walls that obstruct access. Because the food is in the central zone of the confinement, it is a zone that has less humidity and more light than in the inside condition. Seven videos were obtained in these conditions.

2. Condition "inside the dormitory": Condition when the food is dropped by the zoo's caretakers inside the dormitory. The food is located at the dormitory's centre, the main entrance of which is located in the far central zone (LC) of the confinement. This place is approximately 1 m × 2 m, of rectangular form, with four cement walls. More objects within the confinement are not observed. In order to access the food the animal must go through the entrance of approximately 1.5 m × 1.5 m; the dormitory is more humid and darker than other zones of the confinement. Eight videos were obtained in these conditions.

Also, within these two conditions (inside and outside), it was considered pertinent to select more consistent sequences of interaction, recovering and separating those patterns or interaction sequences that were more general, due to the lack of relationship with domination behaviours (i.e. information on the zones with the subjects and with those who interact).

### 2.4 Behavioural Catalogue

General activities

- Eating: to take food and to ingest it, registering the zone where this behaviour happened.
- Resting:
  - Sitting: with legs doubled and half of the body on the ground or on a treetrunk.
  - Hanging: when the subject was hanging with four or two legs on the gratings of the confinement, or some of the trunks that are in the confinement.
  - Lying down: when the subject had its back or belly on the ground or the trunks.
  - Domination-related behaviours.
- Allogrooming: to groom the body of other individual.
  - To give.
  - To receive.
- Agonistic behaviours: set of behaviours that constitute the proximal mechanism of competition. We identify the individual

that initiated or presented/displayed the conduct and towards which individual it was directed (i.e. who received the behaviour).

- Displacement: the emitter moves towards the place that occupies the receiver causing the latter to leave the space, and the emitter occupies it in its place.

  To give.

  To receive.
- Hitting with hands*:* the emitter strikes another member of the group with the legs or hands.

  To give.

  To receive.
- Pursuing*:* a member of the group runs behind another one, by more than a meter of distance; otherwise it is considered as play.

  To give.

  To receive.
- Snatching*:* the emitter takes the food of another member of the group, or it stands up opposite the individual that brings food, in order that the receiver leaves the food on the ground.

  To give.

  To receive.
- Showing teeth: the emitter directs a glance towards another member of the group while it opens the mouth showing the teeth.

  To give.

  To receive.

• Food Access

- Direct: when a member of the group has direct access to the food source, manipulates the food, selects, eating or not what it has selected.
- Indirect: when a member of the group is eating (which implies having the food in the hand or the ground and putting it to the mouth to swallow it), and suddenly this individual stops eating, or throws part of its food, and another member of the group has access to that food left by the emitter. Taking food from another one must occur almost immediately to consider it as indirect access. We register who left or threw the food and who took it.

  To leave food.

  To take food.

## 3 Results

Figure 2 displays the proportion of male and female activity during observation time. White bars show data when food is located inside the enclosure, the gray bars show data when food is located outside the enclosure, and the black bars shows the activity's total frequency. The left graphs show results of male behaviours, and right-sided graphs show female data. The upper graphs display the result of resting activities (i.e. sitting, hanging, lying down); the upper middle graphs show data related to given domination activities (i.e. displacement, pursuing, snatching); whereas the lower middle graphs show data on received domination behaviours. Finally, the lower graphs display the proportion of indirect grabbing of food (i.e. given to or taken from).

In both subjects almost all the activities are related to resting behaviours; in the male the total frequency of resting behaviours is greater when food is located outside, whereas in the female the relation is the opposite. Sitting is the most frequent behaviour emitted in both conditions, followed by hanging. There are no important differences between food conditions.

There are observable differences in domination behaviours between male and female and between food locations. The male shows more dominant behaviours when food is located outside, whereas the female shows it more frequently when food is located inside the enclosure, emitting more dominant behaviours than the male in this condition. In the male, the most frequent dominant behaviour is displacement when food is located inside, and hitting with hands and displacement when food is outside. In the female, the most frequent dominant behaviours emitted are the same (i.e. displacement, hitting with hands) but the relationship of emitted behaviours and food location is the opposite of the male.

The male does not receive any domination behaviour when food is located inside the enclosure, but receives hitting with hands, pursuing, and snatching when food is located outside. The female receives a greater amount of dominant behaviours when food is inside (i.e. displacement, hitting with hands, and pursuing), than when food is located outside (i.e. displacement, pursuing, and hitting with hands).

Finally, results show that the male emits a greater frequency of leaving food when food is outside; of the food left for the male, the juvenile grabs that food more frequently, followed by the female when food is inside or the infant when food is outside. The male only grabbed food indirectly 10 times from the juvenile and female when the food is inside (i.e. two times each), and from the female when the food is outside (i.e. six times). The female leaves food more frequently when food is inside than when food is outside; the juvenile grabs the

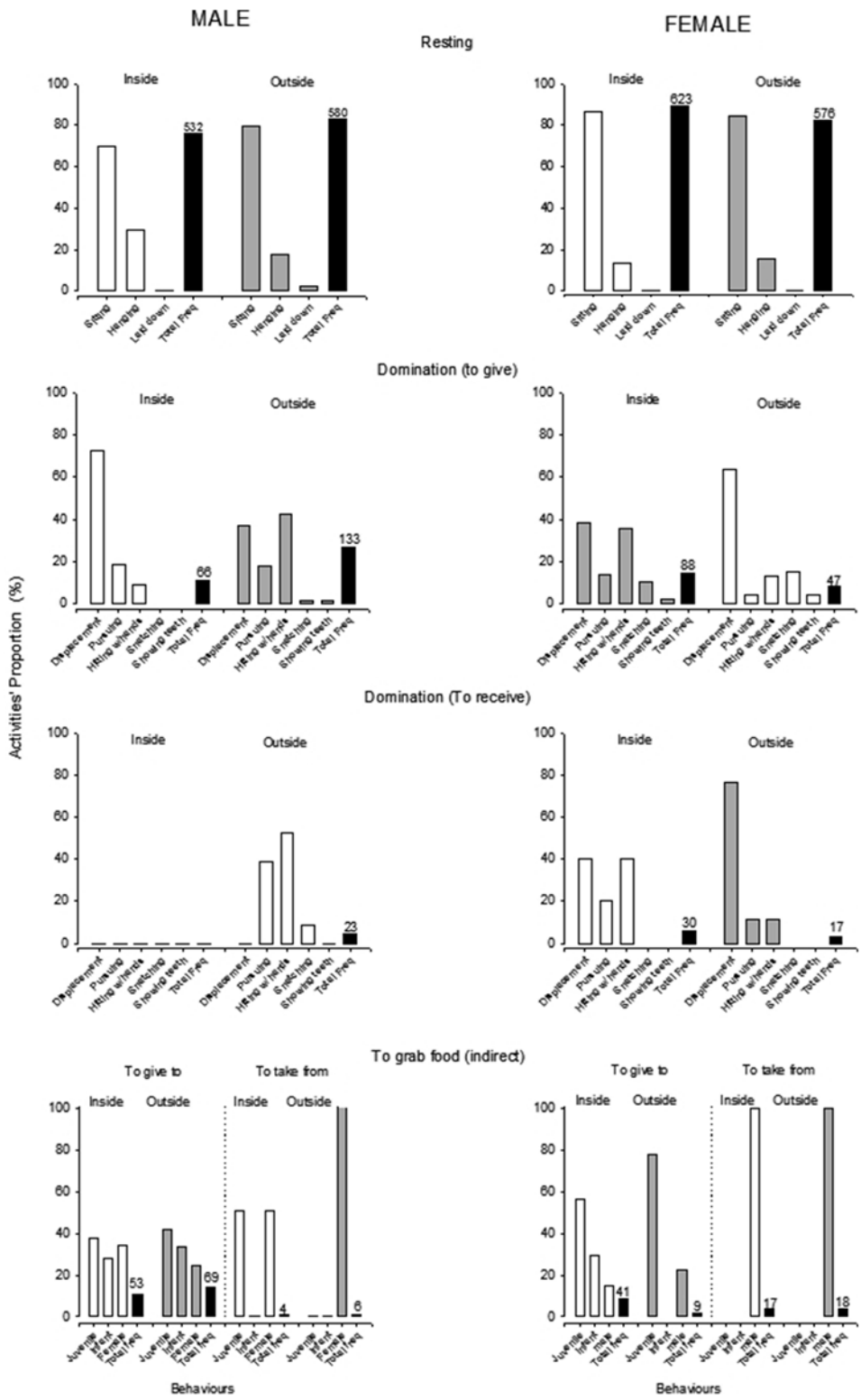


**Fig. 2** Male and female activities as proportion of the observation time

food left by the female almost all the time. The food grabbed by the female is always left for the male.

### 3.1 T-Patterns

In order to examine a temporal patterning of transcribed events the Theme software [25, 26] was used. The data revealed a high number of temporal patterns in all interaction situations. The number, frequency, and complexity of the detected patterns indicate that the transcribed behaviour was very structured. This synchrony was found to exist on different levels, with highly complex time structures that extended over considerable time spans.

Differences by sex (i.e. male, female) and by location of food delivery (i.e. inside, outside) were observed in expressed behaviours and interactive patterns. Figure 3 demonstrates a pattern detected exclusively in the "food inside" group and found in over 90% of observational files. This pattern demonstrates an alternation pattern to food access (hembra/female, macho/male) as a nondomination pattern, as well as that both subjects eat nearby the food source (comerlejoscentro = LC zone).

Figure 4 shows a pattern found exclusively in the "food outside" group and was found in over 90% of observational files. This

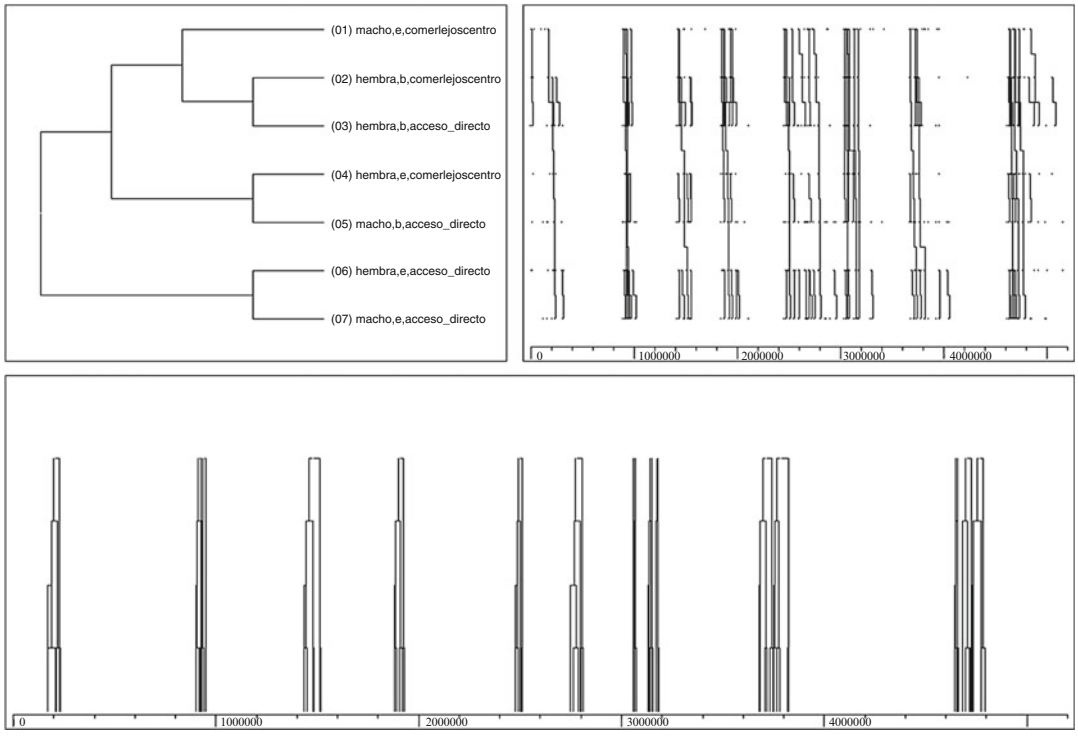


**Fig. 3** Pattern example occurring in over 90% of the "food inside" group data files. Events are (1) male end eat LC zone; (2) female begin eat LC zone; (3) female begin direct access; (4) female end eat LC zone; (5) male begin direct access; (6) female end direct access; and (7) male end direct access

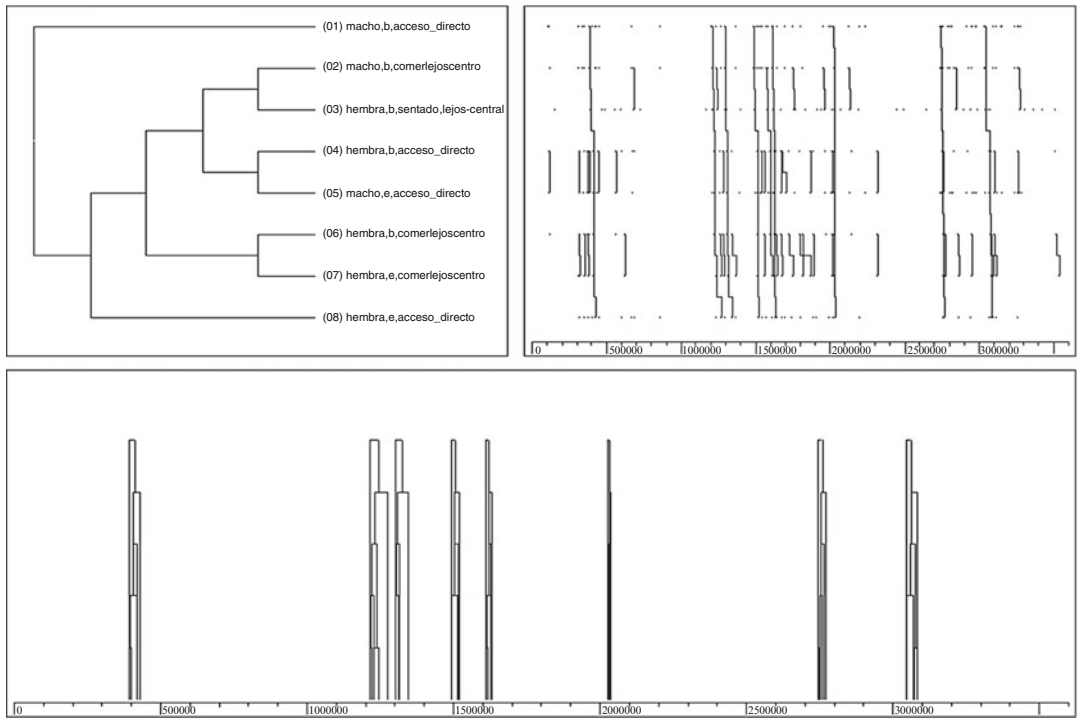


**Fig. 4** Pattern example occurring in over 90% of the "food inside" group. Events are (1) male begin direct access; (2) male begin eat LC zone; (3) female begin sit far central; (4) female begin direct access; (5) male end direct access; (6) female begin eat LC zone; (7) female end eat LC zone; and (8) female end direct access

pattern demonstrates the same alternation pattern to direct food access, although the male (macho) seems to begin this food pattern showing a possible domination pattern.

## 4 Discussion and Conclusion

The results suggest that the females show consistency in patterns related to domination, regardless of where food was placed (i.e. outside-inside). Unlike some data in wild conditions, first access to food is slightly smaller in the female than the male; it appears that the male dominates the female, who seems to dominate the rest of the group suggesting that the conditions of confinement (i.e. group composition) may be a relevant factor for the expression of such patterns. Similarly, the female is consistent with respect to the areas where usually rest (i.e. close to dormitory area) and eating (i.e. far center and right areas) take place. However, we can observe changes related to domination (i.e. agonistic) behaviours associated with the condition. These results may relate to the fact that, in the outside condition, the food is more dispersed and does not have to be fought for.

In general, the male typically shows agonistic behaviours regardless of the condition. It is also observed that when the food is inside, the male snatches the food from the youth and infant, and shows his teeth to the infant, sometimes obtaining reciprocity. However, this does not happen when the food is placed in the outside condition. Allogrooming remains without change and is usually received by the juvenile, the infant, and, to a lesser extent, the female.

Regardless of where the food is placed, the male usually takes it from the female, and sometimes from the youth, and in both conditions the male leaves food that all group members can take. Also, we can observe a limited display of domination behaviours, mainly agonistic ones, that differs from data obtained in wild conditions (i.e. eyelid exhibition, forehead retraction, bipedal position, splay-legged and red, white, and blue displays). Possibly this is because in wild conditions a function of dominance behaviour is to protect or delimit the territory; in captivity conditions (i.e. zoos), the confinement is a bounded area where it is not functional to emit these types of behaviours, inasmuch as there are no predators or intruders. This possible explanation is strengthened by the fact that the splay-legged display was recorded in the areas near visitors.

Meanwhile, female behaviour is usually consistent in receiving domination, displacements, and slapping only by the male. However, the male does not snatch her food nor show his teeth; we did not register dominance behaviours received from members of the group other than the male. These data seem to suggest that the female is really just dominated by the male and manages to dominate the rest of the group because nobody displays dominance behaviours to her, gaining first access to food and eating more than the other members of the group, though slightly less than the male. The female usually displaces and chases the youth in both conditions, generally associated with movement that pushes the youth away from the food source. She does not eat food left by the other members of the group. In wild conditions, the female is usually the dominant one, however, in captivity seems to be dominated by the male. Thus, it appears that the number of females in a group can be an important variable for the development of female dominance behaviours. Data showed a great variety of agonistic behaviour in the female that could lead us to assume a higher hierarchy, allowing her first access to food; however, first access is made by the male.

Ortiz et al. [1] and Ortiz [27] suggest that the classification of this situational adjustment should be made based on the relationships between the emitted behaviours and the situation in which they are presented. This situation should be seen as an array composed of a group of elements, factors, and/or variables that keep a peculiar relationship between them, structuring a network of

interactions. In this way, we can identify at least four types of functional relationships between the behavioural patterns and the situation in which they are presented: (a) interaction or situation-specific behaviour, (b) interaction or behaviour required by the situation, (c) interaction or functional behaviour in the situation, and (d) interaction or irrelevant behaviour to the situation. In this sense, data suggest that this kind of behaviour is required but not quite functional in the situation; and in this sense, it seems necessary to be careful with taking into account only the morphology of behaviour, without identifying the organism adjustment.

Our data suggest the difficulty of sustaining the emergence of fixed patterns of behaviours, especially when conditions in captivity are so different from the wild. We observed changes when altering or changing an element of the situation in the enclosure (i.e. placing the food inside or outside the enclosure), which seems to suggest that modifying an element of a situation can mean that the individual has to change in order to adjust to that change. It is generally considered that the vervet monkey is a species that is able to adapt to conditions of captivity because their eating habits are not very complex and can be adapted to feed on what they have in confinement. In addition, they are considered to be behaviourally flexible, in the sense that when the ecological milieus change, their behaviour changes rapidly. Such as in the case of the female, with no other females in her group, adjusts her behaviours "surrendering" to the male, due to it being stronger, but dominates the rest of the group resulting, in any way, in first access to food, along with the male, selecting the better food. Meanwhile, the male may not display other dominance behaviours (such as those given in wild conditions) because it would not be functional in captivity, as there are no predators or intruders. In this sense, what they do, although it is different from what the species do in wild conditions, seems to be functional and allows adjustment to the condition they are in in captivity, while facilitating adaptation (i.e. reproductive success).

The individuals analysed are adjusting to very particular environmental conditions (i.e. captivity in the Guadalajara Zoo); based on the idea that captivity does not have the same stimuli as that compounding wild conditions, from this perspective so-called psychological well-being would be considered related to deployment of behaviours related to the required criteria by the contingency array or situation (i.e. functional, required, specifics). That is, we need to identify whether the organism is adjusted according to what the situation demands. It is possible that the individuals of a particular troop do not display the fixed action patterns in captivity, and this does not necessarily mean a lack of psychological well-being or that the organism behaviour is "bad" or "inadequate" per se, because the subject does not do what it is supposed to do, according to its species and by what it does in the wild. However, as the captivity condition is different, the animal will behave

differentially given the condition of the particular confinement, adjusting in a different way than in wild conditions. But it is an adjustment and to lower the risk of the animal failing to adapt and reproduce, we must identify what factors contribute to the animal adjusting and adapting to a given confinement. Furthermore, the psychological well-being can be related to the identification of variability, differentiation, modification, integration, and delayed inhibition of its reactions [21], displaying not only behavioural variability, but adjustment to the situation that demands it.

In regard to the temporal patterns detected, the synchrony was found to exist on different levels, with highly complex time structures that extended over considerable time spans, as well as less complex patterns with a shorter time span. The results show that pattern analysis can be used to track elements in the social hierarchy during feeding time (i.e. aggression and dominant behaviour, team structure) in a novel way, indicating that pattern analysis is useful in enhancing existing methods used in animal research. Moreover, some answers have already suggested questions, such as: Are there certain patterns that are related to more aggressive behaviour and place of food delivery? What responses seem to be evoked by certain actions or sequences of actions?

Researchers could use this kind of structural information to increase their understanding of the subject being studied and zoos might benefit from such information when in the process of designing facilities for animals.

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