

Ready to go wild?

A Cercocebus atys lunulatus social behavior evaluation
for its reintroduction.

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Abstract

Cercocebus atys lunulatus (white-naped Mangabey) is an endangered primate species. We have developed an observational social behavior study in Accra zoo (Ghana) of 9 animals split in 3 groups during two periods of time (2011 and 2012) to determine their suitability to be reintroduced into the wild. Our results show that groups were socially compatible and that affiliative indexes were in line with what has been described of wild behaviors in the literature, showing coherence with the dominance ranking, receiving more affiliative behaviors as more dominant the animal was. The largest group changed its dominance dynamics between periods, showing at first a more individual dominance as seen in captivity but more matrilineal during the second, as seen in the wild. Furthermore, trophic behaviors (individual and social) were clearly lower than those observed in the wild. We suggest that given the results more rehabilitation process is needed and follow up in terms of social and trophic behavior should be done before releasing any animals into the wild, in order to increase their chances to survive.

Key words:

White-naped Mangabey, dominance, trophic behavior, affiliative index, Ghana, conservation

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Introduction

Primates social organization

Primates live in a large diversity of social systems that can vary between species, within them (Sterck, 1999 in Kappeler & van Schaik, 2002) and within populations (Goldizen, 1987a; Richard, 1978 in Kappeler & van Schaik, 2002) and that includes aspects such as spacing, grouping and mating patterns (Kappeler & van Schaik, 2002). A primate society can be defined as *the set of conspecific animals that interact regularly and more so with each other than with members of other such societies* (Struhsaker, 1969 in Kappeler & van Schaik, 2002) and can be differentiated by their social organization, mating system and social structure (Kappeler & van Schaik, 2002).

Social organizations can be separated in three groups (Kappeler & van Schaik, 2002): solitary primates, primates in pairs and group-living primates. In solitary primates social organizations individuals forage alone (most species are nocturnal), but this doesn't mean that there are not social relations, is just that they don't have a synchronous activity in space and time with other primates. Primates in pairs, represent a permanent association of one adult male and one adult female (van Schaik and Dunbar, 1990 in Kappeler & van Schaik, 2002), characterized by coincidence of ranges and spatial synchrony and represents one of the rarest type of social organization (Kappeler, 1999c in Kappeler & van Schaik, 2002). Finally, group-living primates are the most common social organization among primates which involve bisexual groups of three or more adults, and these can be classified as polyandrous, polygynous, multimale and multifemale groups (Kappeler & van Schaik, 2002). Depending on the cohesion level groups can also be defined as fission-fusion, which corresponds to groups that can temporary change in size and composition (Nishida and Hiraiwa-Hasegawa, 1987; Rigamonti, 1993; Strier, 1992, in Kappeler & van Schaik, 2002) and that are typically characterized by male philopatry and female dispersal (Swedell, 2012); and multilevel societies which are small social units (one male and several females) that are organized in higher-level sets (Stammach, 1987 in Kappeler & van Schaik, 2002).

In group-living primates individual members interact with one another engaging in different social interactions like communication and affiliative (friendly) and agonistic (aggressive or submissive) interactions. Individuals form and maintain social bonds, which usually are expressed as grooming (behavior involved in the body cleaning and hygiene of one individual by another) (Swedell, 2012). Social live comes with costs and benefits. The firsts include competition for food and water resources, sleeping sites and mates. This competition is mediated by dominance hierarchy what can lead to aggressive conflict resolution with stress, which can affect health and reproduction, physical injuries and in its extreme, death (Swedell, 2012; Caperos *et al.*, 2014). But there are also

benefits such as a better strategy to avoid predation: first there are higher chance of danger detection; second, there is a lower probability of being targeted by a predator (confusion effect) and being hunted (“geometry for the selfish herd”), and third, groups can mob predators away (Swedell, 2012; Caperos *et al.*, 2014). Another benefit are improved mate strategies like better and more diverse mates and more parenthood options (Caperos *et al.*, 2014). Sociability also comes with more connected individuals looking for trophic resources, what ends up with cooperation that allows localization and monopolization of food resources (Swedell, 2012; Caperos *et al.*, 2014). Finally, it has been seen in baboons that strong social relationship with the group, like grooming and strong social bonds can carry important fitness benefits for individuals, increasing offspring survival and longer lifespans (Swedell, 2012).

In order to increase individual’s survival and reproductive success, primates shape and adjust their behavior to cope with the environment. Behavior change response can occur at 3 levels: to meet a specific need, learning and changing the response also to future events, and across population adaptation that will involve greater survivorship or reproduction success and will be emitted to future generations (McPhee & Carlstead, 2010). These changes can also happen in captivity given that these populations are exposed to selective pressures that over generations can shape their behavior compromising the *ex situ* and *in situ* conservation efforts for endangered species (McPhee & Carlstead, 2010). Lack of species-specific interaction of captive animals with the wild environment might cause chronic stress due to space restriction, sounds and olfactory stimulation from predators. Also they might suffer restricted activity levels and lack of activities related to motivated behavior. Finally, lower reproductive behaviors related to inability to court and choose mate, copulate successfully or non-viable offspring are common in captivity. When captive animals show similar behaviors to those observed in the wild, it is considered an indicator of optimal captive environment, good health, well-being and that the animal needs are being met (McPhee & Carlstead, 2010), being then considered a success of conservation effort and suitable for reintroduction programs.

Reintroduction is the deliberated release of species that are in captivity into the wild and is an important conservation tool to battle the high extinction rate. The goal of it is to stablish a free-ranging, reproducible and viable population that was previously captive into the wild, interacting freely with the environment (Clark & Westrum, 1989). The success rate of reintroduction depends on biological factors but also in human management factors (Clark & Westrum, 1989). Among the biological factors are habitat requirements, population, genetic characteristics and behavior. Evaluation of reintroduction programs in primates show that behavior deficiencies like lack of spatial orientation, inability to recognize natural and fine food, failure in avoiding predators and to

recognize appropriate habitat are the cause of many reintroduced animals death (McPhee & Carlstead, 2010).

There are around 500 species from 79 genera of primates distributed in Africa, Madagascar, Asia and Neotropics from which 60% are declared endangered and 75% have declining populations. This is mainly due to habitat loss, but also due to disease, hunting and emerging threats such as climate change (Estrada, *et al.* 2017). In order to reduce the danger of extinction, over 4000 primates in Africa are in rehabilitation centers (Humble & Farmer, 2018). In 2014 the international Union for Conservation of Nature Species Survival Commission Primate Specialist Group (IUCN/SSC PSG), the International Primatological Society (IPS) and the conservation International (CI) selected and published the world's 25 most endangered primates. In Africa are *Galagoides rodonesis*, *Cercopithecus roloway*, *Procolobus rufomitartus* and *Ptilocolobus pennantii pennantii*. According to the IUCN red list, three other African species from the genera *Cercocebus* are endangered (*C.galeritus*, *C.lunulatus* and *C.sanjei*) and all of them should be considered for reintroduction (Schwitzer, C., et al., 2015).

Cercocebus atys lunulatus

Cercocebus atys lunulatus, also named white-naped Mangabey or white-collared Mangabey, is a primate native from Burkina Faso, Côte d'Ivoire and Ghana and is a threatened primate species (Oates, Gippoliti & Groves, 2016). Its population is declining rapidly, showing over a 50% decrease in the last three decades (Encyclopedia of life, 2008). Currently are less than a thousand in the wild and a hundred in captivity (TV3-EI medi ambient, 2012). Although they are tolerant of a wide range of habitats it is threatened by habitat loss caused by deforestation for timber and firewood. The species is locally hunted for meat, and this is an increasingly important threat with ongoing forest fragmentation. Since 1996 it has been included in the Union for Conservation of Nature (IUCN) red list of threatened species and declared as endangered (Oates, Gippoliti & Groves, 2016).

The white-naped Mangabey is typically found in primary and secondary forests, gallery forest, swamp forest including mangrove and mosaic habitats in the Guinean Forest Zone. This species is largely terrestrial but will also use the forest canopy (Oates, Gippoliti & Groves, 2016). The social organization of the sooty Mangabey is characterized by large groups of from 100 to 120 individuals in the wild (Range & Fischer, 2004), even though in some studies smaller groups of 20-48 individuals have been registered (McGraw & Bshary 2002, Range & Noë 2005 in University of Wisconsin, 2011). Groups are multimale and multifemale (Range & Fischer, 2004; Quris, 1975),

showing two categories of males: full-time residents and transient (alternation of weeks of presence and weeks of absence (University of Wisconsin, 2011).

There is a captive population of *Cercocebus lunulatus* in European and African zoos which has the goal of maintenance and conservation of the species. But the population size growth is slow due to few birth per year, high infant mortality and large differences in reproductive success between colonies which globally has an impact in loss of genetic variability in future generations (Gippoliti, Piedimonte & Majolo, 2006). Rearing and breeding failure in these populations is traced back to behavior and species-specific social organization factors given that group sizes in zoos (mostly European) are much smaller than the complex social environment, composed by multi-male and multi-female social groups that can be found in the wild. The poorer environmental and social conditions found in captivity might be a trigger to distressful situations and further negative consequences for females' reproductive physiology, neonatal abandonment and infanticide by the fathers of the infants (Gippoliti, Piedimonte & Majolo, 2006).

In order to establish a healthy, genetically diverse, self-sustaining population of white-naped Mangabey in Ghana, in 2001 the West African Primates Conservation Action (WAPCA) was created. In 2005 WAPCA established the Endangered Primate Centre (EPC) in Accra's zoo (Ghana) with the goal to promote the conservation of the white-naped Mangabey and the Roloway monkey (Sánchez-López *et al.* 2014). In 2010 the white-naped Mangabey and Ghana local communities research and conservation program in Ghana (WMCP) was designed to contribute to this species conservation. WMCP has been developed in Ghana, founded by Barcelona's zoo and scientifically managed by the University of Barcelona (UB) (Sánchez-López *et al.* 2014).

To ensure a reintroduction success, the captive populations need to be self-sustained and have a broad genetic representation. A suitable habitat needs to be chosen, with a release area that comprises sufficient carrying capacity. Also, the factors causing species decline need to be controlled or eliminated (Kleiman, 1989). Furthermore it has to be taken into account that reintroduced specimens might be carrying diseases to which the wild population is not immunized, and consequently this might compromise the wild individuals survival (Kleiman, 1989). Finally it is essential to conduct feasibility studies of the ecology and behavior of wild animals in order to determine the critical needs and establish a line of normal expected behavior (Kleiman, 1989).

Following the previous indications and in order to make the reintroduction successful, the initial threats to the species, like deforestation and hunt need to be controlled (Oates, Gippoliti & Groves, 2016). Then, wide genetically diverse specimens need to be chosen, in order to guarantee a sustainable diversity in the wild. Finally, the selected Mangabey subjects need to be rehabilitated

in their behavior, to adapt it to their needs in the wild and guarantee a successful reintroduction (TV3-EI medi ambient, 2012), which is one of the fundamental pillars of the WMCP: the behavior rehabilitation of captive animals for its reintroduction (Sánchez-López *et al.* 2014).

To develop this final step, it is important to study the social behavior of the white-naped Mangabey subjects in captivity and compare it to the known social behavior of the wild subjects. Primates in captivity have been seen to show behavioral abnormalities not seen in the wild populations such as repetitive behaviors, rocking and/or self-abuse (Yeager, 1997). Also, low social interaction or stimulation from captivity can result in developmental retardation that can be permanent (Yeager, 1997). Furthermore, in terms of social hierarchy and dominance, it has been seen that animals in captivity show an individualistic dominance system which is not matrilineal and neither related to age or gender (Gust, 1995) whereas in the wild mangabey's show strong linear dominance hierarchy, with higher ranking males having best breeding opportunities and females higher security and foraging efficiency (Range, 2006).

The present study will focus on the study of the general behavior of selected captive individuals and their social and dominance relationships compared with those seen in the wild in order to be one step forward in the selection of the suitable subjects for a success reintroduction.

Goals

The main goal is assess the social dynamics of a group of captive Mangabeys in order to determinate which of them show the most similar social behavior compared with their wild conspecifics. The specific goals of the research are:

- Study of the behaviors observed in captivity by housing groups and individuals, with special interest in affiliative and agonistic social behaviors.
- Compare dominance behaviors with the ones described in the literature
- Identify the most suitable animals from a social behavior point of view to be selected for rehabilitation and reintroduction.

Research question: Are there any significant differences between the social dynamic and the way dominance hierarchy is structured in captive animals compared with the literature reports of wild ones?

This study is part of the animal and habitat evaluation of the WMCP project which aims to elaborate a program for the reintroduction of the species to its natural habitat, based on four stages,

according to the IUCN guidelines (Soorase & Baker 2002). The Project was funded by Parque Zoológico de Barcelona, within the Program for Research and Conservation.

Methods

1. Literature review

The genus *Cercocebus* includes the agile Mangabey (*Cercocebus agilis*), the tana river Mangabey (*Cercocebus galeritus*), the white-naped Mangabey (*Cercocebus atys lunulatus*) and the sooty Mangabey (*Cercocebus torquatus atys*) (Fragata, 2010). Given that there is very little information about *Cercocebus atys lunulatus* other species from *Cercocebus* have been also chosen: *Cercocebus torquatus atys* and *Cercocebus galeritus*.

A search through different search sites (Google scholar, PubMed, Scopus, etc) was performed using the following key words and the combination of it: “*Cercocebus lunulatus*”, “reintroduction”, “social behavior”, “rehabilitation”, “wild behavior”. From the found papers others used in their bibliography were also selected.

Two types of information was selected:

- Ethograms: description of behaviors used for the research studies. This gave a base to compare the range of behaviors in the wild with those in captivity.
- Analyzed behaviors: results and conclusions of the research studies. This gave information of more complex behaviors such and dominance hierarchy and the interaction between social behaviors.

2. Subjects

Nine white-naped Mangabey (*Cercocebus atys lunulatus*) were observed in the Endangered Primate Center (EPC) in Accra zoo, Ghana (Table 1).

Animals were distributed in 3 groups, each group in a different housing area, all in outdoor facilities that were close by. The first group was composed by 1 adult male (AM) and 2 adults females (AF) (Ape, Oybiefyee and Accra). The second group by 1 adult male, 1 sub-adult male (SAM), 1 juvenile male (JM) and 1 sub-adult female (SAF) (Ewok, Peter, Sonja and Nuba). In this group there was fifth member that was not observed during this study (Quicke, a juvenile male). The third group

was composed by 1 sub-adult male and 1 juvenile male (Mensah and Annan). In the appendix 1 can be found a drawing of the housing and the distribution of the groups on it.

Table 1: Subjects observed in Accra zoo (Ghana)

Name	Sex	Age	Date/Year of birth	Origin
Accra	Female	Adult (7 years)	17/03/2005	Captive, Barcelona zoo. Accra December 2011
Annan	Male	Juvenile (4 years)	01/08/2008	Captive, EPC, Accra zoo
Ape	Male	Adult (>84 months)	1993	Wild
Ekow	Male	Adult (>84 months)	Not available	Captive, Kumasi zoo
Mensah	Male	Sub-adult (6 years)	07/02/2006	Captive, EPC, Accra zoo
Nuba	Male	Juvenile (24-60 months)	2007	Wild
Oybiefye	Female	Adult (>84 months)	1995	Wild (was a pet for 10 years)
Peter	Male	Sub-adult (6 years)	29/06/2006	Captive
Sonja	Female	Sub-adult (60-84 months)	2006	Wild

This research complied with the protocols approved by the government for the care and handling of animals in the Department of Agriculture, Livestock and Fisheries of the Generalitat de Catalunya (Spain) and the Forestry Commission (Ghana).

3. Data collection

Observations were made in two different periods, the first (P1, from here ahead) between July and September in 2011 and the second (P2, from here ahead) between January and July in 2012. There was only one observer on the first period and there were 3 observers on the second period, which were different from the first one. Each observer did a total of 40 days observations being the total number of observation days in the first period 40 and on the second period 120 days.

A focal animal sample with continuous registration (Matín & Bateson, 2007) of each animal was made each day (approximately). Observations were made from 8 am to 17pm in sessions ranging from 20 to 60 minutes in continuous registration. Subject Accra was only studied during the second period.

3.1. Ethogram

Observed behaviors were classified as individual, social, interspecific and other. Social behaviors were classified in the sub-categories of trophic, affiliation, agonistic and appeasement. For most of observations, the context in which the social behaviors were taking place were registered as alimentation, locomotion or rest.

During social behavior, interactions were registered (emitter and receiver) and a more specific classification of the affiliation and agonistic behaviors was done. For the affiliative ones, the subdivision was comprised by grooming, physical contact, no contact, play and sex. The agonistic were direct threat, indirect threat and attack.

The specific behaviors that comprised each category aforementioned are described in the appendix 2.

4. Data analysis

Data analysis was carried out with Microsoft® Excel (version 16.11, © 2017 Microsoft) and statistical analysis with RStudio program (1.0.143 – © 2009-2016 RStudio, Inc). The analysis was performed at each period for each subject individually and then regrouped by sex, housing group and/or period. Statistical analysis performed comprised t-test and repeated measures ANOVA with each behavior as dependent variable and sex and group as between variables. Statistical significance was established at $p < 0.05$. For t-test analysis between periods, the Accra subject that was only present during P2 was excluded. When the t-test results showed that P1 and P2 were significantly different, further analyses were performed for each period separately.

4.1. Dominance hierarchy

Dominance was calculated by the number of times that the event place impersonation (SPL) was performed. A matrix for each housing group was created indicating the number of time each individual was emitter and/or receiver of the event. Finally the matrix was arranged in a hierarchic order, being on the upper left corner the animals that had performed (emitted) more events and had received less (more dominant animals) and in the lower right corner the animals that had performed (emitted) less events and had received more (less dominant animals) (Martín & Bateson, 2007).

Landau (h) linearity index for group hierarchy dominance was also calculated even though all groups had less than 6 individuals and that implied no statistical significance. The used formula was:

$$h = \frac{12}{n^3 - n} \times \sum_{a=1}^n \left(v_a - \frac{(n-1)^2}{2} \right)$$

where n is the total number of animals in the group and v_a is the number of animals being dominated (receivers) by an individual. h ranges from 0 to 1, being 0 none linear and 1 linear.

4.2. Relative individual dominance

Relative individual dominance (RID) was calculated for each individual using the relative dominance index (FCEyN-UBA):

$$d_{ij} = \frac{p}{n} - \frac{n-p}{n}$$

were d_{ij} is the relative dominance between subject “i” and subject “j”; p is the number of interactions win by “i” and n is the number of interactions between “i” and “j”. Interactions win were considered as all agonistic behaviors emitted to other individuals (p) and the total number of interactions was considered as the addition of all agonistic behaviors received and emitted (n). For groups that had more than 2 members calculation was done with all won interactions (emitted) and all received interactions (by all members with the studied individual). Individual relative dominance ranged from -1 to 1, being 1 the most dominant relative individual range.

4.3. Social status

Social status of each individual was calculated with the displacement index (Galindo & Broom, 2002) that ranges from 0 to 1, being 1 the highest rank of social status.

$$\text{Displacement index} = \frac{A}{A+B}$$

were A is the number of times that the animal displaces other individuals and B the number of times the animal is displaced by other individuals. Displacements were counted as the number of social impersonations (SPS) emitted (A) and received (B).

4.4. Directional consistency

Directional consistency (DC) quantifies the directionality of a social behavior interaction. It was calculated with the affiliative behaviors by dyads within the group by using the formula:

$$DC = \frac{H-L}{H+L}$$

were H is the number of most frequent interactions and L the number of less frequent direction within each dyad. The DC can be also calculated for the group by the sum of absolute dyadic discrepancies divided by the total number of interactions (Leiva, 2009). The range goes from 0 to 1, being 0 the maximal range of reciprocity and 1 unidirectional dyadic interactions.

4.5. Sociability

Sociability and the capacity of making alliances with other member groups was calculated with the affiliation index (Galindo & Broom 2002 Galindo XXX):

$$Affiliation\ index = \frac{x}{x + y}$$

where x is the number of times that the animal transmit an affiliative behavior to other individuals and y the number of times the animal receives affiliative behaviors from other individuals. Range goes from -1 to 1, being -1 the subjects that receive more affiliative behaviors than they give (more loved-well considered within the group) and 1 the individuals that give more affiliative behaviors than they receive (seek for social relations, approbation for the other group members).

Results

1. Literature review

No information was found regarding the wild behaviors of *Cercocebus atys lunulatus*. Other species of the genera were selected, always selecting observations from wild animals. Table 15 in the appendix 3 shows some of the observed behaviors in the literature. All behaviors described in the literature were also in the observational ethogram.

From Range & Noë, (2002) in a study of *Cercocebus torquatus atys* it was seen that the foraging efficiency was more 74%, being feeding 28.79% and searching 45.18%. Coalitions were also seen between females, with a maximum of 4 grooming partners, with a trend to prefer only one.

In relation to dominance, Range & Noë, (2002) and Range (2006) describe a linear ranks and in some cases triadic relationships. The degree of unidirectionality of dominance relationship observed in the wild was $DC=0.91-0.96$, and $h= 0.33-0.71$.

2. Animals social dynamics

The results show that the mean time of observation per animal at each period was approximately of 30 minutes per session (Table 2). No animal was excluded of the analysis.

Table 2: Mean time of observation per animal during period 1 and 2 (NA stands for not applicable)

Subject	Total time observation(s)		Days observation		mean time(s)/day		mean time(min)/day	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
Accra	NA	202630	NA	116	NA	1747	NA	29.1
Annan	71700	224069	37	117	1938	1915	32.3	31.9
Ape	76560	201530	40	117	1914	1722	31.9	28.7
Ekwo	75240	192057	40	118	1881	1628	31.4	27.1
Mensah	73800	206328	38	114	1942	1810	32.4	30.2
Nuba	75240	221388	39	117	1929	1892	32.2	31.5
Oybiefye	75420	246646	39	117	1934	2108	32.2	35.1
Peter	76680	222389	40	118	1917	1885	32.0	31.4
Sonja	75600	245183	38	117	1989	2096	33.2	34.9
Average	75030	218024	39	117	1931	1867	32.2	31.4
Stand. Dev	1614	19183	1.13	1.20	31	162	0.51	2.77
TOTAL	600240	1962220	311	1051				

2.1. Type of behavior

Results show that behaviors changed in frequency and duration between periods, showing lower taxes for all of them during the second period (Table 3 & Table 4). There were significant differences at individual behavior ($t(7)=16.194$; $p<0.001$), social behavior ($t(7)= 6.623$; $p<0.001$) and interspecific behavior ($t(7)=5.999$; $p<0.001$). Further analysis by sex and housing group is performed separately for each period.

Table 3: Results by type of behavior during period 1 (n=8)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	36530	0.7120	3.6516	431231	0.7185	11.8048
Social Behavior	8906	0.1736	0.8903	95399	0.1589	10.7118
Interspecific Behavior	2183	0.0425	0.2182	19621	0.0327	8.9881
Others	3690	0.0719	0.3689	53973	0.0899	14.6268
TOTAL	51309	1.0000	5.1290	600224	1.0000	46.1315

Table 4: Results by type of behavior during period 2 (n=9)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	53776	0.9296	1.6443	1861015	0.9484	34.6068
Social Behavior	2717	0.0470	0.0831	84045	0.0428	30.9330
Interspecific Behavior	1243	0.0215	0.0380	14290	0.0073	11.4964
Others	113	0.0020	0.0035	2870	0.0015	25.3982
TOTAL	57849	1.0000	1.7689	1962220	1.0000	102.4344

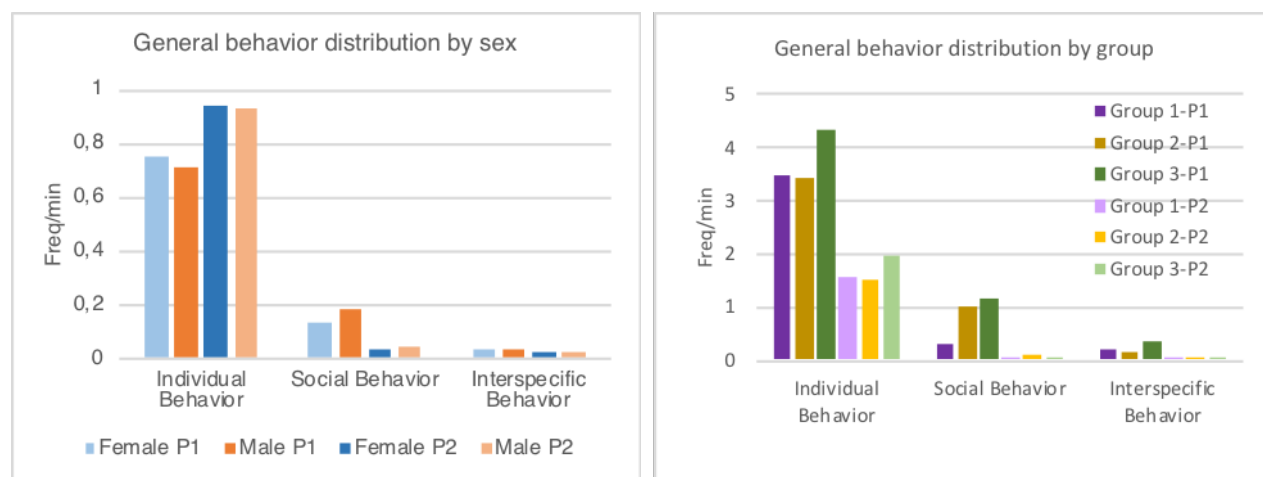


Figure 1: On the left behavior tax (individual, social and interspecific) by sex. On the right behavior tax by housing group [G1(P1):1AM, 1AF; G1(P2):1AM, 2AF; G2: 1AM, 1SAM, 1JM, 1SAF; G3: 1SAM, 1JM].

Results of behavior type by sex, group and individual animals can be found in the appendix 4 (Table 16 to Table 19).

There were significant differences at all behaviors between both periods, showing the 2011 period higher taxes than the 2012 period. As a whole, observed animals at both periods spend the highest amount of time and frequency performing individual behaviors (frequency P1 71.2% and P2 92.9% and time P1 71.8% and P2 94.8%). This was followed by social behavior (frequency P1 17.4% and P2 4.7% and time P1 15.9% and P2 4.3%) and the latest was interspecific behavior (frequency P1 4.3% and P2 2.2% and time P1 3.3% and P2 0.7%). During the second period most of the time and frequency spent was concentrated in individual behaviors, whereas during the first period behaviors were more split between the three categories. The mean duration of all types of behavior was longer in the second period than in the first, being up to 3 times for individual and social behaviors. This differences were maintained when analyzing by sex and housing group.

Repeated measures ANOVA showed that group was significant for social behavior during the first period ($F_{1,5}=12.018$; $p<0.018$). Group 1 had the lowest tax of social behavior at both periods, being significant only during the first period. Group 3 had a trend towards a higher tax of individual behavior at both periods, but no significance was found. There were no significant differences by sex at any behavior or period, but males showed a trend towards higher social behaviors during the first period.

Trophic behaviors were also studied in order to compare them with what was found in the literature. The analysis was done for individual and social behaviors jointly and related to the total behaviors time and frequencies for each period (Table 5).

Table 5: Trophic behavior

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Trophic behavior P1	995	0.0194	0.0995	13249	0.0221	13.3156
TOTAL P1	51309			600224		
Trophic behavior P2	7764	0.1342	0.2374	319653	0.1629	41.1712
TOTAL P2	57849			1962220		

2.2. Social behavior

Results show that behaviors changed in frequency and duration between periods, showing changes in preference between them (Table 6 & Table 7). There were significant differences between periods at trophic behavior ($t(7)=3.579$; $p<0.009$), affiliative behavior ($t(7)= 3.166$; $p<0.015$) and appeasement behavior ($t(7)=2.679$; $p<0.032$). No significant differences were found between periods for the agonistic behavior ($t(7)=-0.084$; $p=0.935$).

Table 6: Results by social behavior during period 1 (n=8)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Trophic	995	0.1117	0.6258	13249	0.1389	13.3156
Affiliation	4659	0.5231	2.9302	56274	0.5899	12.0786
Agonistic	1343	0.1508	0.8447	9450	0.0991	7.0365
Appeasement	1909	0.2143	1.2006	16426	0.1722	8.6045
TOTAL	8906	1.000	5.6013	95399	1.000	41.0351

Table 7: Results by social behavior during period 2 (n=9)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Trophic	17	0.0063	0.0121	1029	0.0122	60.5294
Affiliation	1788	0.6581	1.2765	74961	0.8919	41.9245
Agonistic	518	0.1907	0.3698	3708	0.0441	7.1583
Appeasement	394	0.1450	0.2813	4347	0.0517	0.0000
TOTAL	2717	1.000	1.9397	84045	1.000	109.6122

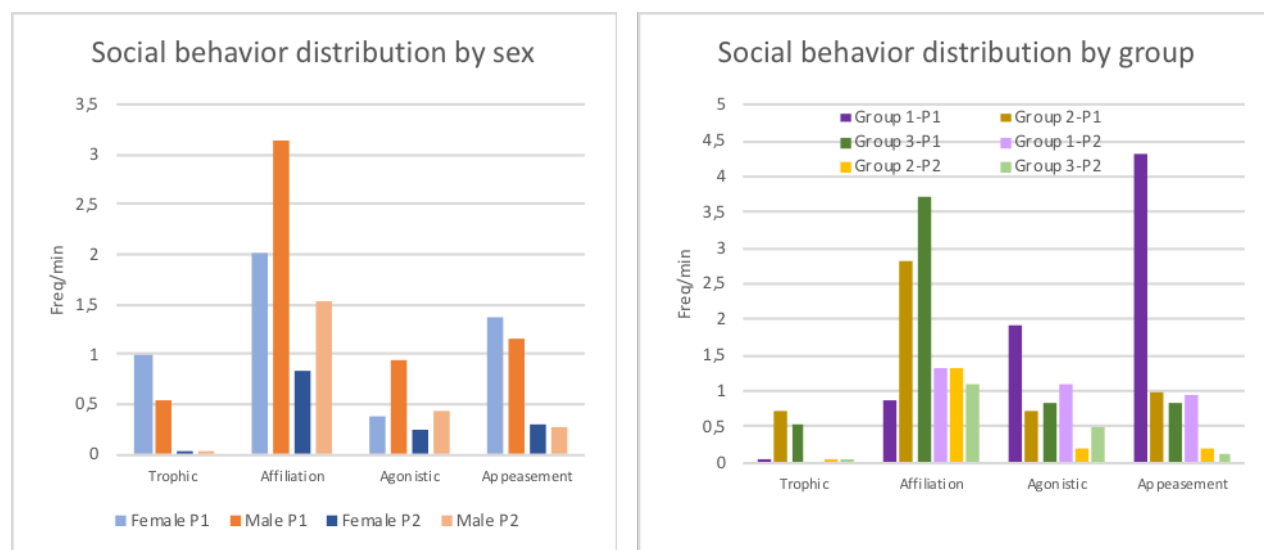


Figure 2: On the left social behavior tax (trophic, affiliation, agonistic and appeasement) by sex. On the right social behavior tax by housing group (G1(P1): 1AM, 1AF; G1(P2): 1AM, 2AF; G2: 1AM, 1SAM, 1JM, 1SAF; G3: 1SAM, 1JM).

Results of social behavior type by sex, group and individual animals can be found in the appendix 5 (Table 20 to Table 23).

Among social behaviors, at both periods the trophic ones were the ones presenting the lower tax (11.2% at P1 and 0.6% at P2) and affiliation the higher (52.3% at P1 and 65.8% at P2). Females presented the double tax of trophic behavior than males (P1F tax: 0.999; P1M tax: 0.535; P2F tax: 0.018; P2M tax: 0.009). Repeated measures ANOVA showed no significant differences for any social behavior, but affiliation had the lower p value at P2 ($F_{1,6}=5.777$; $p<0.053$), being higher for males than for females at both periods (Figure 2).

The analysis by housing group showed that trophic behaviors were close to 0 (or 0) for the first group, being this significantly lower than the other groups during the second period ($F_{1,6}=10.126$; $p<0.019$). Significant differences by group were found for affiliation during the first period ($F_{1,5}=15.217$; $p<0.014$) but not during the second, being the affiliation in group number 3 the highest, and in group number 1, the lowest (Figure 2). At both periods, group 1 showed the highest agonistic behavior and group 2, the lowest, showing no significant differences with repeated measures ANOVA. Finally we could see that group 1 had higher appeasement than the other groups at both periods, being significant during the second period ($F_{1,6}=7.179$; $p<0.036$).

2.3. Affiliation

Results show that behaviors changed in frequency and duration between periods, showing changes in preference between them (Table 8 & Table 9). There were significant differences at grooming ($t(7)=2.487$; $p<0.042$), physical contact ($t(7)=4.343$; $p<0.003$), non-contact ($t(7)=2.592$;

$p < 0.036$) and play behaviors ($t(7) = 2.519$; $p < 0.040$). No significant differences were found between periods for sexual behavior ($t(7) = 1.923$; $p = 0.096$).

Table 8: Results by social behavior affiliation during period 1 (n=8)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Grooming	478	0.1026	0.5096	14108	0.2507	29.5146
Physic contact	914	0.1962	0.9745	11183	0.1987	12.2352
No contact	868	0.1863	0.9255	8311	0.1477	9.5749
Play	1791	0.3844	1.9096	17649	0.3136	9.8543
Sex	608	0.1305	0.6483	5023	0.0893	8.2615
TOTAL	4659	1.0000	4.9675	56274	1.0000	69.4405

Table 9: Results by social behavior affiliation during period 2 (n=9)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Grooming	307	0.1717	0.2457	32942	0.4395	107.3029
Physic contact	185	0.1035	0.1481	6640	0.0886	35.8919
No contact	463	0.2589	0.3706	20600	0.2748	44.4924
Play	541	0.3026	0.4330	10786	0.1439	19.9372
Sex	292	0.1633	0.2337	3993	0.0533	13.6747
TOTAL	1788	1.0000	1.4311	74961	1.0000	221.2991

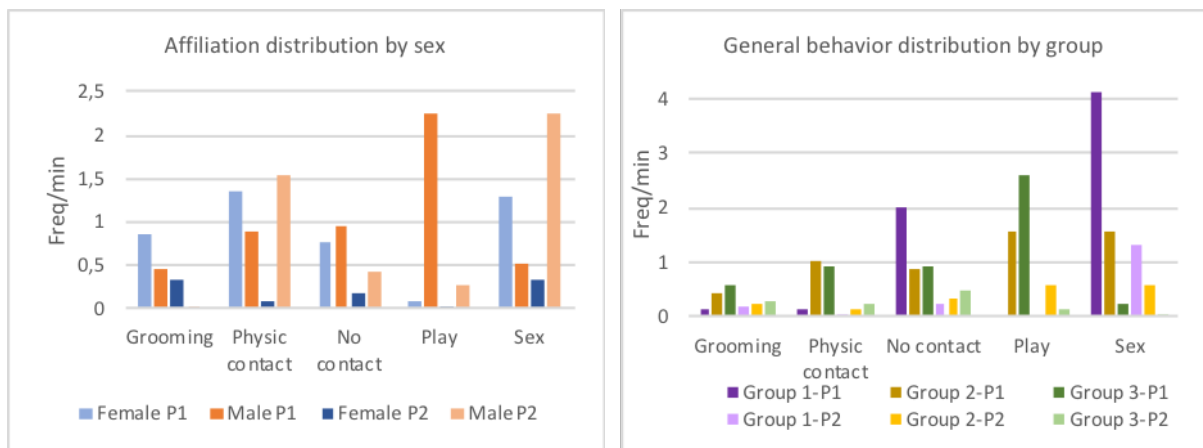


Figure 3: On the left affiliative behavior tax (grooming, physic contact, no contact, play and sex) by sex. On the right affiliative behavior tax by housing group [G1(P1): 1AM, 1AF; G1(P2): 1AM, 2AF; G2: 1AM, 1SAM, 1JM, 1SAF; G3: 1SAM, 1JM].

Results of affiliative behavior type by sex, group and individual animals can be found in the appendix 6 (Table 24 to Table 27).

Repeated measures ANOVA showed significant differences by sex during the second period for grooming ($F_{1,6} = 8.525$; $p < 0.027$) and physical contact ($F_{1,6} = 6.324$; $p < 0.046$). No other behavior was significant during second period or first period. Females presented a higher tax than males for

grooming at both periods. Taxes of physical contact and sex changed depending of the period, being both behaviors higher for females during the first period and higher for males during the second period. Males also showed a higher tax than females for no contact agonist behaviors. Play was the affiliative behavior with the highest tax during first period, being higher for males. Adult males (Ape and Ekow) presented the lower taxes of play behaviors (being close to 0, similar to the females). The higher taxes of play were seen in subadult (Peter and Mensah) and juvenile (Nuba) males.

Repeated measures ANOVA showed significant differences by housing group during the first period in grooming behavior ($F_{1,5}=25.735$; $p<0.004$) and during the second period in sex behavior ($F_{1,6}=10.126$; $p<0.019$). At both periods groups 1 and 2 showed higher taxes of sexual behavior than group 3, being this last the only group composed exclusively by males (Mensah and Annan). During first period, grooming was higher for groups 2 and 3. At that time, group 1 was composed by one adult male and one adult female (during P2 a second female adult was added to the group). At both periods physic contact and play were higher in groups 2 and 3 than group 1, being this last formed only by adult members.

2.4. Agonistic

Results show that there were no significant differences by any of the agonistic behaviors between periods. Data was analyzed for both periods separately (Table 10 & Table 11) but also combined as one (Table 12).

Table 10: Results by social behavior agonist during period 1 (n=8)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Direct threat	685	0.5101	4.3492	5012	0.5304	7.3168
Indirect threat	271	0.2018	1.7206	1745	0.1847	6.4391
Attack	387	0.2882	2.4571	2693	0.2850	6.9587
TOTAL	1343	1.0000	8.5270	9450	1.0000	20.7146

Table 11: Results by social behavior agonist during period 2 (n=9)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Direct threat	280	0.4690	3.9307	2341	0.5477	8.3607
Indirect threat	155	0.2596	2.1759	769	0.1799	4.9613
Attack	162	0.2714	2.2742	1164	0.2723	7.1852
TOTAL	597	1.0000	8.3809	4274	1.0000	20.5072

Table 12: Results by social behavior agonist during periods 1 and 2 (n=9)

	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration
Direct threat	965	0.4974	4.2189	7353	0.5358	7.6197
Indirect threat	426	0.2196	1.8624	2514	0.1832	5.9014
Attack	549	0.2830	2.4002	3857	0.2810	7.0255
TOTAL	1940	1.0000	8.4815	13724	1.000	20.5466

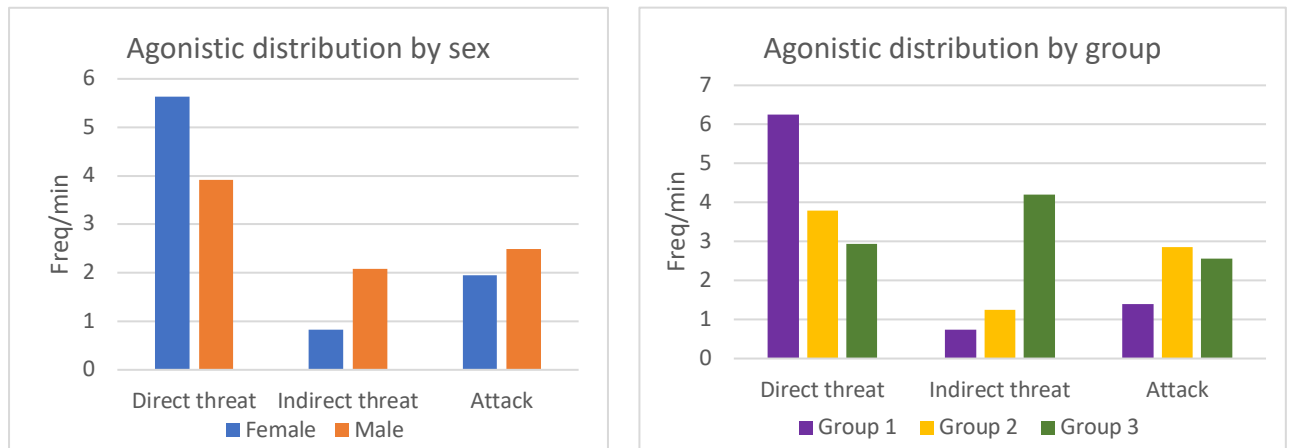


Figure 4: Data for both periods combined. On the left affiliation behavior tax (direct threat, indirect threat and attack) by sex. On the right affiliation behavior tax by housing group [G1:1AM, 2AF; G2: 1AM, 1SAM, 1JM, 1SAF; G3: 1SAM, 1JM].

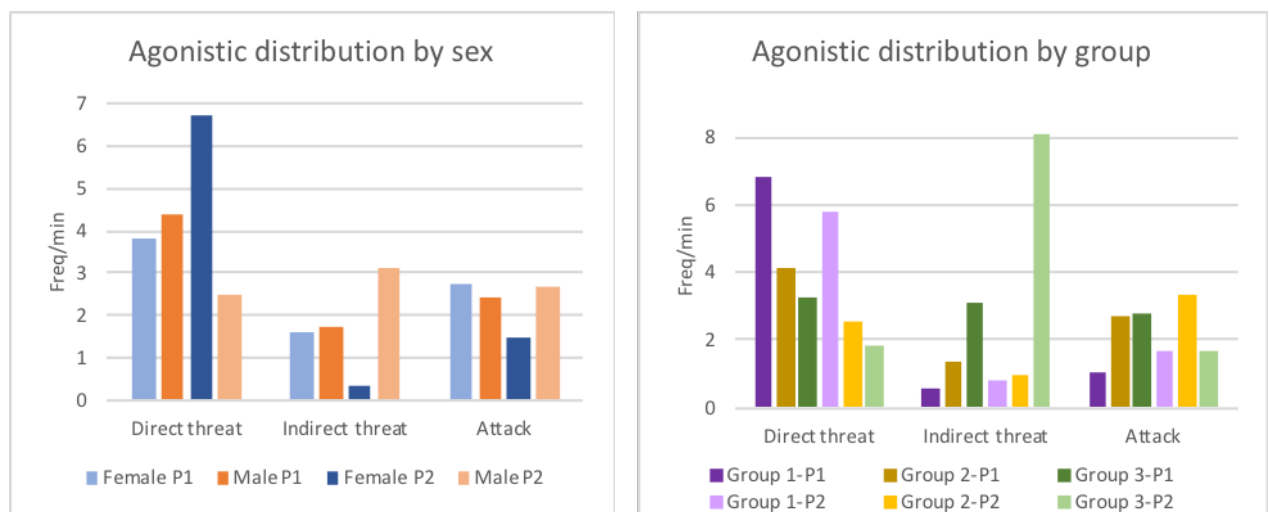


Figure 5: On the left affiliation behavior tax (direct threat, indirect threat and attack) by sex. On the right affiliation behavior tax by housing group [G1(P1):1AM, 1AF; G1(P2):1AM, 2AF; G2: 1AM, 1SAM, 1JM, 1SAF; G3: 1SAM, 1JM]

Results of agonistic behavior type by sex, group and individual animals can be found in the appendix 7 (Table 28 to Table 31).

Repeated measures ANOVA showed that none of the agonistic behaviors was significant neither for sex or for housing group when analyzed as both periods merged. Only direct threat was close to significance for sex ($F_{1,6}=5.582$; $p<0.056$) and for group ($F_{1,6}=5.726$; $p<0.053$). Direct threat was

the agonistic behavior with the highest tax, presenting females a higher tax than males, and being group 1 (composed only by adult members) the one with the higher tax (Figure 4).

When analyzing both periods separately, repeated measures ANOVA showed significant differences for attack during the first period ($F_{1,5}=8.583$; $p<0.033$) and for indirect threat during second period ($F_{1,6}=10.798$; $p<0.017$). Group 1 presented the lowest tax of attack. During first period, this group was composed by one adult male and one adult female. Indirect threat was higher for group 3 (at both periods), which was composed by one sub-adult male and one juvenile male.

2.5. Group dominance hierarchy

Only during the first period were enough place impersonation behaviors (SPL) to calculate dominance relationship between housing group members. Sociometric tables of SPL events can be found on appendix 8 (Table 32, Table 33 and Table 34).

Given that in groups 1 and 3 there were only two members in each dominance relationships were limited. Results show that in Ape, an adult male dominated Oybiefye, an adult female ($h=0.1$) and Mensah, a sub-adult male dominated Annan, a juvenile male ($h=0.1$).

Dominance in group 2 was linear ($h= 1.0$) with two middle positions. Ekow, an adult male, was the most dominant animal in the group, having performed place impersonation to all the other members and having never been impersonated. Then Sonja, a sub-adult female, and Nuba a juvenile male, were the seconds more dominant, having both performed place impersonation to two members of the group and being place impersonated also by two members. Sonja performed and received less place impersonation events than Nuba, but Sonja was also less socially active than Nuba (279 vs 532 total number of social behaviors, from which 9 vs 90 were appeasement). The least dominant member of the group was Peter, a sub-adult male that never performed a place impersonation event, and was receiver of this behavior by the three other group members, being Nuba who did it more times.

2.6. Directional consistency

Directional consistency was calculated for dyads and for groups (Table 13). Results show that most of the dyads were close to 0, meaning a high reciprocity between individuals. At group level, there was an increase in DC at period 2, being in all groups above 0.2. Affiliative sociometric matrices are in appendix 9 (from Table 35 to Table 40).

Table 13: DC for dyads and groups by period

Dyads/Groups	DC period 1	DC period 2
Accra-Ape	NA	0.18
Accra- Oybiefy	NA	0.08
Ape- Oybiefy	0.13	0.00
Nuba-Ekow	0.01	0.05
Nuba-Peter	0.02	0.00
Nuba-Sonja	0.11	0.04
Ekow-Peter	0.01	0.05
Ekow-Sonja	0.06	0.01
Peter-Sonja	0.02	0.08
Annan-Mensah	0.15	0.26
Group 1	0.13	0.26
Group 2	0.21	0.23
Group 3	0.15	0.26

2.6. Individual social status

Social impersonation (SPS) behavior was used to calculate the Index displacement (ID), which can be used to determine the social status of each individual. SPS behaviors were only observed during the first period in group 2. Results showed that Ekow had the highest social status (ID=1.0), closely followed by Nuba (ID=0.9), then Sonja (ID=0.33) and finally Peter (ID=0.07).

Relative individual index of dominance (RID) and index of affiliation (AI) can also be used to know the social status and sociability trends of each individual. All index were performed for each period separately. During the second period some agonistic behaviors were observed between animals of different housing environments. This behaviors were also taken into account for the calculations. Results show that there were no significant differences between periods at dominance index ($t(7)=-0.327$; $p=0.753$) and at affiliation index ($t(7)=0.864$; $p=0.416$) (Table 14).

As individuals, results show that the most dominant animal during first period was Ekow and the lowest was Peter. During second period the most dominant animal was Ape and the lowest was Annan. For affiliative behaviors, during the first period Sonja was the one receiving more and Nuba the one giving more. During the second period Oybiefy was the one receiving more and Annan the one giving more.

Table 14: Individual index of relative dominance and affiliation index at each period

Individual	Sex	Age	Group	RID (P1)	RID (P2)	AI (P1)	AI (P2)
Ape	M	A	1	0,68	0,88	-0,13	-0,22
Oybiefye	F	A	1	-0,68	-0,07	0,13	-0,40
Accra	F	A	1	NA	-0,24	NA	0,26
Ekow	M	A	2	0,92	0,83	0,17	0,02
Peter	M	SA	2	-0,95	0,43	-0,01	0,21
Nuba	M	J	2	0,24	-0,78	0,19	-0,01
Sonja	F	SA	2	0,30	-0,11	-0,40	-0,25
Mensah	M	SA	3	0,49	0,84	-0,15	-0,25
Annan	M	J	3	-0,49	-0,85	0,15	0,26

When analyzing the dominance results by group, we can see that at individual level, the rank of the animals in groups 1 and 3 did not change between periods. For group 1, we saw that in period 2 the last incorporation had the lower dominance index, raising the previous female index (Oybiefye) close to 0. In group 3 the dominance index of the adult male was increased from period 1 to period 2, and consequently the dominance of the juvenile male was reduced. In group 2 changes between periods were conditioned by sex and age. During the first period, the dominance ranking was MA>FSA>MJ>MSA; but in the second period the dominance rank is MA>MSA>FSA>MJ.

Affiliative index showed that for groups 1 and 3, during the first period affiliative behavior was in correspondence with dominance ranking, receiving more affiliative behaviors as more dominant the animal was (and giving more as less dominant). This trend was maintained for group 3 during the second period. In group 1, for the second period, the incorporation of the new female member, made the other female member receive more affiliative behaviors than the dominant male, what might indicate the beginning of alliance between females. Group 2 showed in both periods a clear preference towards the female, being her the one receiving more affiliative behaviors (and giving less). The males ranking in this group changed between periods. During the second period the three males gave more affiliative behaviors than during the first period, decreasing down to 0 for the juvenile and the adult (equal amount of received and given behaviors), and increasing the number of affiliative behaviors emitted for the subadult male (Peter).

Sociometric matrix for SPS events is in the appendix 10 (Table 41) and for agonistic behaviors are in appendix 11 (Table 42 and Table 43).

Discussion

Differences found between period 1 and period 2 could be related to the changes of the animals and their dynamics over time. Also, should be taken into account that observers between periods were different and that only observers from second period were validated. The few behaviors that showed no significant differences between periods, when later analyzed by sex and group showed different results, so even though at individual level there were no differences, as a group, changes were notorious. Another main difference seen between periods was the time spent per behavior, which was longer during second period.

At both periods most time and frequency was spent in individual behaviors, showing a very little presence of social relations of any kind. The statistical analysis of the different types of social behaviors show that females had a higher tax of grooming and direct threat whereas males showed higher taxes of physical contact and play, being this last inversely correlated with age.

The amount of total trophic behaviors observed in the captive animals was very low, being almost negligible during the first period, but increased in the second period rising up to a quarter of what has been seen in the wild (in the wild 74% of the time (Range & Noël, 2002) vs 2.2% during the first period and 16.3% during the second period). Among social behaviors, during both periods trophic ones presented the lowest tax, being in females the double than in males and in housing group number 1 close to 0 during second period (being significantly lower than the others). This results are in line with the idea that in the wild conditions are tougher than in captivity (Humble & Farmer, 2018) and that animals might get overindulged in captivity. Also given that is an endangered species, in the wild conditions might be even more extreme, leading to more extreme behaviors.

Directional consistency was close to the maximum social reciprocity for all dyads, with the only exception of Annan & Mensah, the two adult males that composed group 3 and Accra & Ape the adult male and the new adult female of group 1. This lower reciprocity might be also related with the dominance ranking, being Mensah and Ape, the two dominant adult males in each group the ones receiving more affiliative behaviors. But even in those cases DC was much lower than what has been reported from wild observations (above 0.9 in the wild vs below 0.3 in captivity observations). In the wild social relationships might be more linked to survival, promoting affiliative behaviors sex and range related (Ehardt, 1988) as seen in the studied animals, and then also more susceptible to lower reciprocity and higher index of unidirectional interactions. The increase observed at group level from period 1 to period 2 might be indicating a trend towards a more wild behavior.

The study of social behaviors per housing group showed that for all groups at both periods there were more affiliative behaviors than agonistic ones, showing that groups were socially compatible, since social relationships among individuals were not neutral and the number of aggressions was very low (Fàbregas & Guillén-Salazar, 2007). Statistical analysis showed that group 1, when was composed by one adult male and one adult female (P1) had the lowest tax of social behavior, with the lowest affiliation, grooming and tax of attack. In period two, when the second adult female was introduced, this group showed compared to the others the lowest trophic behavior and the highest appeasement, which was mostly due to the new female member. This new member (Accra) also showed a higher affiliative index which was also related to a more unidirectional interaction with the adult male of the group. Even though affiliative associations in trophic context between females have been seen in the wild (Range & Noë, 2002), the behavior of the new adult female was more in line with the wild observations of adult females having a greater affiliation with adult males (Ehardt, 1988).

Group 3, which was composed by two adult males, showed the highest affiliation during the first period, and the lower sex tax (as expected) and higher indirect threat in the second period. The adult male showed a higher rank of dominance than the juvenile male during both periods, which is in agreement with what has been seen in the wild (Range 2006).

Members of group 2 changed their dominance ranking from first to second period. In the first one dominance ranking was not related to sex or age (not matrilineal), but in the second dominance showed strong linear dominance hierarchy ranking by sex and age as it is seen in linear hierarchies in wild animals, with higher ranking males having best breeding opportunities and females higher security and foraging efficiency (Range, 2006). The female of the group was the one receiving more affiliative behaviors what would be related with some kind of social power not related to aggressive dominance but to kindness. For groups 1 and 3 individual affiliative indexes were in coherence with the dominance ranking, receiving more affiliative behaviors as more dominant the animal was. These results are in line with what has been seen in previous studies where females trend to have affiliative behaviors depending on age and range (Ehardt, 1988; Range & Noël, 2002).

The landau linearity indexes were not similar to those observed in the literature ($h=0.33-0.71$), but the number of individuals in each group was too low, so the obtained landau from the observed data should only be taken as an indicative result.

At individual level and in relation to the others, the ones that were more stable in dominance ranking between periods were Annan, Ekow and Sonja, and the more susceptible to change were Peter and Obey. The ability to change ranking between periods can be related with adaptability to the social environment, a trait that could be very useful in the wild.

The differences found between the observed behaviors and the ones reported in the literature leads us to suggest that some more rehabilitation work should be done before releasing the animals into the wild. The amount of trophic behaviors should increase in order to ensure that animals have the ability to survive in a more hostile environment, before being released, given that this has been seen a potential cause of death in reintroduced animals (McPhee & Carlstead, 2010). Being able to create alliances and adapt to new groups is another potential characteristic that should be taken into account. At dominance level, seems that in terms of group animals were readapting their behavior acquiring a more matrilineal hierarchy. In this direction, the animal that has shown a higher level of adaptation and change between periods was Peter, a sub-adult male that was in the housing group number 2.

Conclusions

In relation to the main goals and research question of this study our results show that:

- The study of social behaviors per housing group showed that groups were socially compatible, since social relationships among individuals were not neutral and the number of aggressions was very low.
- Group 2, which was the largest group, showed a change in dominance dynamics between periods, being during the first a more individual dominance as seen in captivity but more matrilineal during the second, as seen in the wild.
- Affiliative indexes were in line with what has been described of wild behaviors in the literature, showing coherence with the dominance ranking, receiving more affiliative behaviors as more dominant the animal was.
- Trophic behaviors (individual and social) were clearly lower than those observed in the wild.
- At this point, the animal that has shown a higher level of adaptation and change was Peter, a sub-adult male that was in the housing group number 2, but we suggest that given the results more rehabilitation process and follow up in terms of social and trophic behavior should be done before releasing any animals into de wild, in other to increase their chances to survive.

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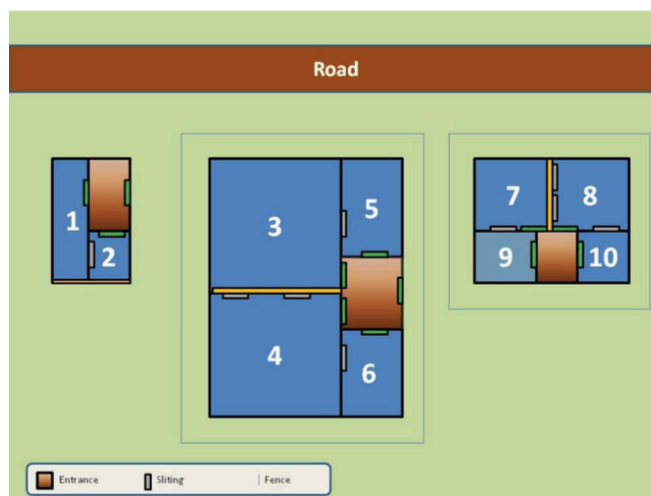
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Appendix

1. Housing and groups distribution

Facility	Number grup	Name of animal	Age/sex category
3	1	Ape, Oyeibiyefe Accra	AM, AF, AF
4	2	Peter, Ekow, Sonja, Nuba, Quicke	SAM, AM, SAF, JM2, JM1
8 and 10	3	Mensha, Annan	SAM, JM2

AM: adult male; AF: adult female; SAM: subadult male; SAF: subadult female; JF: juvenile female; JM: juvenile male; IM: infant male



2. Ethogram in captivity

Individual Behavior			
<i>Trophic</i>	BUA	Search	Exploration and/or manipulation of environment /substrate looking for food. Subject can be still or showing slow movements
	ISA	Inspection	By hand manipulation of food and/or trophic items
	OBA	Obtain food	Pick up nourishment without ingestion
	CON	Consumption	Active ingestion of solid food
	BEB	Drink	Active ingestion of liquid food
	REG	Regurgitation	Backward flowing of food from the stomach
	CAP	Consumption with previous search	Active ingestion of solid food that has been previously find by exploration and/or manipulation of environment /substrate
	CAO	Consumption with previous obtaining	Active ingestion of solid food that has been previously picked up
<i>Static</i>	SEN	Sit	Static position in which subject's weight is supported by its buttocks
	CUA	Quadruped	Static position in which subject's weight is supported by its four limbs
	TUM	Lying down	Static position in which subject's weight is supported by some part of its body in its length (ventral, lateral or dorsal)
	ERG	Erect	Static position in which subject's weight is supported by its lower limbs. Upper limbs can be moviment free or standing somewhere else.
<i>Locomotion</i>	CAM	Walk	Slow movement displacement of the subject in quadruped posture without any other activity being performed.
	SAL	Jump	Subject propels with his lower limbs and rises in the air with his arms oriented towards the objective of the jump.
	COR	Run	Fast movement displacement of the subject in quadruped posture without any other activity being performed.

	TRE	Climb	The subjects moves (displacement) up or down in a vertical surface such as slopes or logs.
<i>Body care</i>	ASE	Clean up	To separate the corporal hair with the hand and to take elements of its skin with the fingers or with its mouth in a sitting position.
	RAR	Scratch	Rubbing a part of the body using the nails of hands or feet.
	OLF	Sniff	Persistently smell some part of its own body.
<i>Exploration</i>	EXV	Visual exploration	Carefully observe inedible objects or its own stools
	EXO	Olfactory exploration	Carefully smell inedible objects or its own stools
	EXG	Tastefully exploration	Carefully taste (put in mouth) inedible objects or its own stools
	MAN	Manipulation	Tactile exploration of non-edible objects or its own feces
<i>Instrument</i>	HUR	Rummage its own body with a log	Move a log inside a body hole or cavity.
	CGI	Hold an instrument	Pick up an object and grab it with the hand.
<i>Play</i>	JUL	Locomotion play	Playful behavior in which the individual moves (i.e. races, jumps)
	JAC	Acrobatics	Playful behavior in which the individual does not move (i.e. tumbling)
	JEQ	Equilibrium	Playful behavior in which the individual moves on ropes, trunks or other structures.
	RAM	Pick up branches	Playful behavior in which the individual manipulates branches or other objects.
<i>Sex</i>	IGE	Genitals inspection	The individual cleans, scratches or smells the genital area. Normally in a sitting posture.
	MAS	Masturbation	The male manipulates its penis by grasping it with the hand to cause ejaculation. Sitting posture
	SEM	Semen intake	The individual takes the semen to his mouth and swallows it.
<i>Abnormal</i>	BAL	Swinging	Moving back and forth or from side to side while walking
	PIR	Abnormal pirouette	performed a repetitive pirouette, pushing himself with his hand and doing a cartwheel in the corner of the room.
	EST	Stretch skin	sometimes when he sat down, stretched the skin of his penis with his mouth and kept it tense for a while.
	MOV	Head movement	in front of the researcher, performed repetitive movements back and forth with the head and adopted a rocking sitting posture.
	PAC	Pacing	Walk at a steady speed, especially without a particular destination and with neutral expression
	PIP	Pipa	Put the thumb in the mouth and suck it.
<i>Reaction</i>	EXA	Exalt	Continuous and repetitive displacement in the same area in a situation of alertness and / or social tension.
Social behavior			
<i>Trophic</i>	EXT	Collective extraction	Food handling and/or trophic enrichment carried out by more than one individual.
	COA	Sharing	Eat from the same source of solid or liquid food; an individual tolerates another eating from the same place.
	SOA	Request	The individual approaches his mouth to that of another individual who is eating while looking at him or sniffing the other individual's food.

	CGA	Cath food without aggression	The individual takes food from the hand of another individual without aggression.
	SGA	Follow another subject	The individual moves behind the way of another individual who possesses a trophic item
	CON+	Parallel consumption	Food ingestion (solid or liquid) near other individuals when the distance between them allows physical interaction.
	MAM	Nurse	The individual sucks one of the breasts of the female while subjected to the mother or seated.
<i>Affiliative</i>			
Grooming	GRO	Grooming	The individual removes hair from the body of another individual with one or two hands and collects elements of his skin, either with the index finger and thumb (hand), or with the mouth directly on the skin.
	SOG	Request Grooming	The individual approaches another presenting its buttocks in position quadruped and with forward head; or sits close to another individual performing self-grooming; or lies down near another individual.
	NOG	Deny Grooming	After a grooming request, one individual ignores the other or moves away from him.
Physic contact	OLB	Sniff mouth	Approaching another individual and sniffing his mouth.
	ABR	Hug	Surrounding with its arms another individual's body through the ventral, dorsal or lateral area while at rest or movement
	CGC	Catch tail	Hold the tail of another individual with his hands.
	TOC	Touch	Touching, supporting or rubbing another individual in any part of the body.
	MON	Mount	Climb on the back of another individual.
	TRP	Transport	The individual moves through the facility while the baby remains ventrally or dorsally attached to his body.
	APA	Push away	Remove another individual by gently hand pushing or pushing with other part of the body.
	SOS	Hold	Take the baby between the legs in a sitting position for more than 1 minute.
	COL+	Be together	Sit or stretch close to another individual maintaining physical contact and without performing any other social activity.
No Contact	DSP	Move together	Walk close to another individual performing both the same route
	APR	Approach	Displacement of one or more individuals that were initially distant and end up being closer
	SEG	Follow	The individual moves behind the path of another individual
	COL	Be close/next	Sit or stretch in a position close to another individual, when the maximum distance between the two is equal to the extension of their limbs.
Play	JUP	Persecution game	The individual advances running or trotting ahead or behind another individual that moves forward at the same speed.
	JUC	Contact game	Playful behavior in which the individual struggles, bites another individual without moving and without agonistic intention.
	JUO	Game with object	The individual manipulates one or several objects in a recreational way with another individual.
	JUT	Transportation game	Playful behavior in which an individual moves transporting another individual ventrally or dorsally
	SOJ	Request game	The individual jumps on another individual or pulls with his hand or both hands the tail, the hair of the body of another individual or an object that is grabbing.

Sex	MGE	Genitals manipulation	To touch superficially with the fingers, or to inspect closely with the sight and without touching the genitals of another individual.
	OGE	Genitals olfactory inspection	Approach and smell the genitals of another individual.
	ORI	Female urine inspection	Touch, smell or approach to the mouroh the urine mark that a female leaves when she is in zeal.
	PGE	Show genitals	Approach another individual presenting the buttocks in quadruped position so that the genitals are at the height of the other individual's head.
	EGE	Genitals exhibition before copulation	In the moment prior to copulation, approach another individual presenting the buttocks in quadruped position so that the genitals are at the height of the other individual's head.
	LEN	Tongue	The individual moves the tongue in and out of his mouth quickly and repeatedly addressed to another individual.
	COP	Copulation	The male mounts the female holding on to the rump with her hands and resting its feet on the legs of the female. Moves the pelvis front and back for a long time. It ends with ejaculation
	SGH	Follow female	The male moves behind the path of the female in zeal.
	CDH	Touch female hip	The male touches or grabs the female's hip with one or both hands.
	CLH	Touch female tail	The male touches or grabs the female's tail with one or both hands.
	OPE	Smell pectorals	The female approaches the nose to the male's pectorales and smells them.
	SPC	Sit after copulation	The individual adopts a sitting position at the end of the copulation
	EXP	Joint exploration	Carefully observe, smell or taste inedible objects with another subject or its own/other's stools.
<i>Agonistic</i>			
Attack	PER+	Chase with contact	The aggressor runs after another individual. During the race there is contact (hits, holds etc)
	CAR	Leap on	The aggressor abruptly advances towards the other individual from a short distance and stops abruptly
	GOL	Hit	The aggressor beats another individual with the open hand.
	TIR	Pull	The aggressor holds a part of another person's body with his hand and holds it with a strip of it.
	LUC	Fight	The aggressor and the assaulted wrestle with hands, feet or another part of the body without moving.
	MOR	Bite	The aggressor arrests the other individual with the mouth or teeth with the intention of causing harm.
	SAC	Shake	Grab on the housing wall (net) and move (the animal) up and down or from side to side with rapid, forceful, jerky movements
	SAP	Request support	Extend the hand towards another individual with or without physical contact or look at him during an agonistic episode.
	APO	Give support	An individual who has not started agonistic behavior joins the individual who has initiated agonistic behavior to attack a third individual in coalition
	RED	Redirect	The individual who has been subject to agonistic behavior performs agonistic behavior on a third individual.

Direct threat	PER	Chase without contact	The aggressor runs after another individual. During the race there is no contact.
	DIE	Show teeth	The individual with the body in tension shows teeth persistently to another individual.
	APR+	Fast approach	The individual moves sharply towards the other individual from a long distance.
	BOS	Yawn	The individual closes the eyes and opens the mouth showing the teeth. Seated, raised or upright posture
	AME	Threat	Suddenly the individual tenses the neck and head in the direction of another individual. The mouth can be closed or open but without showing the teeth. The ears are tilted and the gaze is fixed.
Indirect threat	DIS	Display	Move quickly, walking or jumping, in front of another animal persistently.
	DSO	Display with object	Running, jumping or impacting strongly with its feet or hands against a surface or an object of the installation, causing noise and/or displacement of the element.
	CAB	Shake head	Move head up and down with gaze fixed on the other individual.
	SPS	Social impersonation	Take the place of another individual to obtain some kind of social benefit: female (copulation), grooming, proximity to another individual.
	SPT	Trophic impersonation	Take food from another individual who had it in possession.
<i>Appeasement</i>	DEF	Self defense	In response to an aggression: show teeth, hit, threaten the aggressor.
	MIR	Stare	Keep the gaze fixed on another individual for more than 2 seconds without moving any other body part.
	VIG	Look out	Locate and guide the vision towards a group or subject.
	HUI	Run away	Rapid displacement of an individual immediately after being threatened and/or assaulted by another individual in the group.
	ALE	Move far away	The individual moves away from the place where he was, increasing the distance between him and another individual.
	DOM	Dominance	The individual grabs another individual from the hip and pulls him towards him. Later can stand on the submissive individual or not.
	SUM	Submission	The individual slowly approaches another individual and shows him the buttocks with the tail erect. Turns its head towards that individual.
	SLP	Place impersonation	The individual approaches another individual who moves away from the position he occupied previously.
Interspecific behavior			
<i>Towards audience</i>	MIP	Look at	Interaction or search for interaction with humans including the observer. Is consider both affiliative interactions (eg, observing, inciting the game) and agonistic ones
	SVP	Follow visually	Guide the vision towards a human group or subject.
	DIP	Show teeth	The individual with the body in tension shows teeth persistently to a human.
<i>Towards caregivers</i>	RED+	Redirect	Attack to a conspecific after exaltation by caregivers
	MIC	Look at	Interaction or search for interaction with caregivers. Is consider both affiliative interactions (eg, observing, inciting the game) and agonistic ones
	SVC	Follow visually	Guide the vision towards a caregiver.
	SDC	Follow	The individual moves behind the path of the caregiver

<i>Towards researchers</i>	SVI	Follow visually	Guide the vision towards a researcher.
	DII	Show teeth	The individual with the body in tension shows teeth persistently to a researcher.
	MII	Look at	Interaction or search for interaction with researchers. Is consider both affiliative interactions (eg, observing, inciting the game) and agonistic ones
<i>Vocalizations</i>	VOC	Vocalizations	Sounds emitted vocally
Other: All behaviors observed that were not included in the previous ones and not studied in the present work were classified as “others”.			

3. Ethogram from wild animals (literature review):

Table 15: *literatura review of wild behaviours of Cercocebus*

Author, year	Species	Where	Sex, age	Activity	behavior	Description
René Quris, 1975	<i>Cercocebus galeritus</i>	M'Bondou, Liboui	Females and males various ages	Maintenance activity	<i>Locomotor activity</i>	NA
					<i>Displacement</i>	NA
					<i>Vertical displacement</i>	NA
					<i>Alimentation</i>	NA
				Social	<i>Harem social organization</i>	NA
					<i>Vocal manifestation</i>	NA
Males	<i>Sound n°4</i>	High intensity scream (600-1000m)				
René Quris, 1980	<i>Cercocebus galeritus</i>	Liboui			Types of screams	Differentiation by duration, frequency and harmony
Range & Noé, 2002. (Table 1)	<i>Cercocebus torquatus atys</i>	Taï National Park in south-western Ivory Coast	24 females, 7-13 males. Focal animal sampling	Maintenance activity	<i>Feeding</i>	<i>Animal sits or stands at one place and puts objects in its mouth continuously, moving its jaws, emptying its cheek pouches or the animal sits at one place and opens a food-containing object with its teeth, hands and feet.</i>
					<i>Searching</i>	<i>Animal moves slowly forward while visually scanning the forest floor, occasionally putting objects in its mouth.</i>
					<i>Traveling</i>	<i>Animal walks steadily forward without visually scanning the forest floor.</i>
					<i>Resting</i>	<i>Combines behavior like grooming, playing, sitting or sleeping.</i>
					Social	<i>Yield</i>
				<i>Avoid</i>		<i>The actor leans aside or shifts body position in</i>

Author, year	Species	Where	Sex, age	Activity	behavior	Description
						<i>response to another individual that approaches or walks by.</i>
					<i>Crouch</i>	<i>The belly is close to the ground. The crouch may occur during a severe physical attack, signaling complete submission [Bernstein, 1976].</i>
					<i>Stare</i>	<i>The actor raises the eyebrows and forehead while staring directly at a target animal; the head can be rapidly lowered and raised while exhibiting the stare.</i>
					<i>Stare and lunge</i>	<i>After the stare the actor darts rapidly towards the recipient, but stops before reaching the recipient at which time the actor lowers its shoulders as in preparation to jump forward.</i>
					<i>Fighting</i>	<i>Any hard aggressive contact: biting, hitting, gripping and fighting.</i>
					<i>Taking place</i>	<i>The actor takes the place of the recipient after the recipient is threatened or pushed away.</i>
					<i>Non-agonistic supplant</i>	<i>The actor approaches another individual who is occupying a resource and replaces that individual without overt aggression.</i>
					<i>Grooming</i>	<i>The actor cleans the fur of the recipient with the mouth and/or hands [Altmann, 1962].</i>
					<i>Invite groom</i>	<i>The actor can use various behaviours to illicit grooming from another individual: the actor presents and/or exposes a part of his body to reactor while standing or sitting stiffly [Hinde & Rowell, 1962].</i>
					<i>Ventral-hug</i>	<i>The actor approaches a seated animal and lifts its leg onto the shoulder of the seated reactor. It moves its head towards</i>

Author, year	Species	Where	Sex, age	Activity	behavior	Description
						<i>the genital area of the seated reactor.</i>
					Hugging	<i>The actor places the arm on the recipient's shoulder. One or both animals may rise onto two legs or remain seated and place both arms around the other's ventrum.</i>
					Touch	<i>The actor lightly places one of its hands on the reactor.</i>
					Approach	<i>The actor moves into the reactor's space ($r < 2m$).</i>
					Agonistic support	<i>An intervention of a third individual in an agonistic dyad on behalf of one individual, directed against its opponent.</i>
					Coalition	<i>The combined agonistic interaction of two animals against one opponent.</i>

4. Behavior type

Table 16: Behavior type by sex and period

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	P1	F	2	8506	0.7501	3.3794	104895	0.6946	12.3319
Social Behavior	P1	F	2	1486	0.1310	0.5904	18671	0.1236	12.5646
Interspecific Behavior	P1	F	2	379	0.0334	0.1506	3568	0.0236	9.4142
Others	P1	F	2	969	0.0854	0.3850	23886	0.1582	24.6502
TOTAL	P1	F	2	11340	1.000	4.5054	151020	1.0000	58.9609
Individual Behavior	P2	F	3	17695	0.9376	1.5288	658179	0.9478	37.1958
Social Behavior	P2	F	3	724	0.0384	0.0626	30820	0.0444	42.5691
Interspecific Behavior	P2	F	3	433	0.0229	0.0374	5200	0.0075	12.0092
Others	P2	F	3	21	0.0011	0.0018	260	0.0004	12.3810
TOTAL	P2	F	3	18873	1.0000	1.6306	694459	1.0000	104.1550
Individual Behavior	P1	M	6	22552	0.7070	3.5918	262863	0.6978	11.6559
Social Behavior	P1	M	6	5958	0.1868	0.9489	67207	0.1784	11.2801
Interspecific Behavior	P1	M	6	1236	0.0388	0.1969	11225	0.0298	9.0817
Others	P1	M	6	2150	0.0674	0.3424	35429	0.0940	16.4786
TOTAL	P1	M	6	31896	1.0000	5.0800	376724	1.0000	48.4963
Individual Behavior	P2	M	6	31229	0.9284	1.6408	1075509	0.9418	34.4394
Social Behavior	P2	M	6	1591	0.0473	0.0836	55584	0.0487	34.9365
Interspecific Behavior	P2	M	6	757	0.0225	0.0398	9054	0.0079	11.9604
Others	P2	M	6	62	0.0018	0.0033	1787	0.0016	28.8226
TOTAL	P2	M	6	33639	1.0000	1.7675	1141934	1.0000	110.1589

Table 17: Behavior type by housing group and period

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	P1	1	2	8787	0.7834	3.4690	119225	0.7845	13.5683
Social Behavior	P1	1	2	834	0.0744	0.3293	7038	0.0463	8.4388
Interspecific Behavior	P1	1	2	497	0.0443	0.1962	4442	0.0292	8.9376
Others	P1	1	2	1098	0.0979	0.4335	21275	0.1400	19.3761
TOTAL	P1	1	2	11216	1.0000	4.4280	151980	1.0000	50.3210
Individual Behavior	P2	1	3	17231	0.9380	1.5886	633699	0.9737	36.7767
Social Behavior	P2	1	3	607	0.0330	0.0560	10838	0.0167	17.8550
Interspecific Behavior	P2	1	3	497	0.0271	0.0458	5446	0.0084	10.9577
Others	P2	1	3	34	0.0019	0.0031	823	0.0013	24.2059
TOTAL	P2	1	3	18369	1.0000	1.6935	650806	1.0000	89.7953
Individual Behavior	P1	2	4	17243	0.6979	3.4173	211975	0.7002	12.2934
Social Behavior	P1	2	4	5205	0.2107	1.0316	59492	0.1965	11.4298
Interspecific Behavior	P1	2	4	844	0.0342	0.1673	8137	0.0269	9.6410
Others	P1	2	4	1415	0.0573	0.2804	23140	0.0764	16.3534
TOTAL	P1	2	4	24707	1.0000	4.8966	302744	1.0000	49.7175
Individual Behavior	P2	2	4	22440	0.9132	1.5282	817671	0.9281	36.4381
Social Behavior	P2	2	4	1608	0.0654	0.1095	55924	0.0635	34.7786
Interspecific Behavior	P2	2	4	458	0.0186	0.0312	6140	0.0070	13.4061
Others	P2	2	4	68	0.0028	0.0046	1282	0.0015	18.8529
TOTAL	P2	2	4	24574	1.0000	1.6736	881017	1.0000	103.4758
Individual Behavior	P1	3	2	10500	0.6824	4.3299	100031	0.6875	9.5268
Social Behavior	P1	3	2	2867	0.1863	1.1823	28869	0.1984	10.0694
Interspecific Behavior	P1	3	2	842	0.0547	0.3472	7042	0.0484	8.3634
Others	P1	3	2	1177	0.0765	0.4854	9558	0.0657	8.1206
TOTAL	P1	3	2	15386	1.0000	6.3447	145500	1.0000	36.0802
Individual Behavior	P2	3	2	14105	0.9463	1.9663	409645	0.9518	29.0425
Social Behavior	P2	3	2	502	0.0337	0.0700	17283	0.0402	34.4283
Interspecific Behavior	P2	3	2	288	0.0193	0.0401	2704	0.0063	9.3889
Others	P2	3	2	11	0.0007	0.0015	765	0.0018	69.5455
TOTAL	P2	3	2	14906	1.0000	2.0780	430397	1.0000	142.4052

Table 18: Behavior type by animal during P1

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	Annan	JM	5862	0.7306	4.9054	51098	0.7127	8.7168
Social Behavior	Annan	JM	1282	0.1598	1.0728	12555	0.1751	9.7933
Interspecific Behavior	Annan	JM	366	0.0456	0.3063	2970	0.0414	8.1148
Others	Annan	JM	514	0.0641	0.4301	5077	0.0708	9.8774
TOTAL	Annan	JM	8024	1.0000	6.7146	71700	1.0000	36.5023
Individual Behavior	Ape	AM	4478	0.7663	3.5094	61324	0.8010	13.6945
Social Behavior	Ape	AM	425	0.0727	0.3331	3677	0.0480	8.6518
Interspecific Behavior	Ape	AM	345	0.0590	0.2704	2908	0.0380	8.4290
Others	Ape	AM	596	0.1020	0.4671	8651	0.1130	14.5151
TOTAL	Ape	AM	5844	1.0000	4.5799	76560	1.0000	45.2904
Individual Behavior	Ekow	AM	3638	0.6561	2.9011	55946	0.7436	15.3782
Social Behavior	Ekow	AM	1241	0.2238	0.9896	11960	0.1590	9.6374

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Interspecific Behavior	Ekow	AM	236	0.0426	0.1882	2518	0.0335	10.6695
Others	Ekow	AM	430	0.0775	0.3429	4816	0.0640	11.2000
TOTAL	Ekow	AM	5545	1.0000	4.4219	75240	1.0000	46.8851
Individual Behavior	Mensah	SAM	4638	0.6300	3.7707	48933	0.6630	10.5505
Social Behavior	Mensah	SAM	1585	0.2153	1.2886	16314	0.2211	10.2927
Interspecific Behavior	Mensah	SAM	476	0.0647	0.3870	4072	0.0552	8.5546
Others	Mensah	SAM	663	0.0901	0.5390	4481	0.0607	6.7587
TOTAL	Mensah	SAM	7362	1.0000	5.9854	73800	1.0000	36.1565
Individual Behavior	Nuba	JM	4558	0.6984	3.6348	53349	0.7091	11.7045
Social Behavior	Nuba	JM	1484	0.2274	1.1834	15516	0.2062	10.4555
Interspecific Behavior	Nuba	JM	200	0.0306	0.1595	1851	0.0246	9.2550
Others	Nuba	JM	282	0.0432	0.2249	4508	0.0599	15.9858
TOTAL	Nuba	JM	2	0.0003	0.0016	16	0.0002	8.0000
Individual Behavior	Oyibiefye	AF	4309	0.8021	3.4280	57901	0.7677	13.4372
Social Behavior	Oyibiefye	AF	409	0.0761	0.3254	3361	0.0446	8.2176
Interspecific Behavior	Oyibiefye	AF	152	0.0283	0.1209	1534	0.0203	10.0921
Others	Oyibiefye	AF	502	0.0934	0.3994	12624	0.1674	25.1474
TOTAL	Oyibiefye	AF	5372	1.0000	4.2737	75420	1.0000	56.8943
Individual Behavior	Peter	SAM	4850	0.7271	3.7950	55686	0.7262	11.4816
Social Behavior	Peter	SAM	1403	0.2103	1.0978	16706	0.2179	11.9073
Interspecific Behavior	Peter	SAM	181	0.0271	0.1416	1734	0.0226	9.5801
Others	Peter	SAM	236	0.0354	0.1847	2554	0.0333	10.8220
TOTAL	Peter	SAM	6670	1.0000	5.2191	76680	1.0000	43.7911
Individual Behavior	Sonja	SAF	4197	0.7033	3.3310	46994	0.6216	11.1970
Social Behavior	Sonja	SAF	1077	0.1805	0.8548	15310	0.2025	14.2154
Interspecific Behavior	Sonja	SAF	227	0.0380	0.1802	2034	0.0269	8.9604
Others	Sonja	SAF	467	0.0783	0.3706	11262	0.1490	24.1156
TOTAL	Sonja	SAF	5968	1.0000	4.7365	75600	1.0000	58.4884

Table 19: Behavior type by animal during P2

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	Accra	AF	6101	0.9366	1.8065	194480	0.9598	31.8767
Social Behavior	Accra	AF	310	0.0476	0.0918	7367	0.0364	23.7645
Interspecific Behavior	Accra	AF	97	0.0149	0.0287	731	0.0036	7.5361
Others	Accra	AF	6	0.0009	0.0018	52	0.0003	8.6667
TOTAL	Accra	AF	6514	1.0000	1.9288	202630	1.0000	71.8440
Individual Behavior	Annan	JM	7601	0.9535	2.0354	212299	0.9475	27.9304
Social Behavior	Annan	JM	288	0.0361	0.0771	11007	0.0491	38.2188
Interspecific Behavior	Annan	JM	78	0.0098	0.0209	670	0.0030	8.5897
Others	Annan	JM	5	0.0006	0.0013	93	0.0004	18.6000
TOTAL	Annan	JM	7972	1.0000	2.1347	224069	1.0000	93.3389

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Individual Behavior	Ape	AM	5300	0.9224	1.5779	195477	0.9700	36.8825
Social Behavior	Ape	AM	162	0.0282	0.0482	2188	0.0109	13.5062
Interspecific Behavior	Ape	AM	258	0.0449	0.0768	3105	0.0154	12.0349
Others	Ape	AM	26	0.0045	0.0077	760	0.0038	29.2308
TOTAL	Ape	AM	5746	1.0000	1.7107	201530	1.0000	91.6543
Individual Behavior	Ekow	AM	3545	0.8912	1.1075	183250	0.9541	51.6925
Social Behavior	Ekow	AM	366	0.0920	0.1143	7899	0.0411	21.5820
Interspecific Behavior	Ekow	AM	53	0.0133	0.0166	730	0.0038	13.7736
Others	Ekow	AM	14	0.0035	0.0044	178	0.0009	12.7143
TOTAL	Ekow	AM	3978	1.0000	1.2428	192057	1.0000	99.7624
Individual Behavior	Mensah	SAM	6504	0.9380	1.8914	197346	0.9565	30.3423
Social Behavior	Mensah	SAM	214	0.0309	0.0622	6276	0.0304	29.3271
Interspecific Behavior	Mensah	SAM	210	0.0303	0.0611	2034	0.0099	9.6857
Others	Mensah	SAM	6	0.0009	0.0017	672	0.0033	112.0000
TOTAL	Mensah	SAM	6934	1.0000	2.0164	206328	1.0000	181.3551
Individual Behavior	Nuba	JM	6906	0.9102	1.8716	206722	0.9338	29.9337
Social Behavior	Nuba	JM	532	0.0701	0.1442	12673	0.0572	23.8214
Interspecific Behavior	Nuba	JM	131	0.0173	0.0355	1568	0.0071	11.9695
Others	Nuba	JM	18	0.0024	0.0049	425	0.0019	23.6111
TOTAL	Nuba	JM	7587	1.0000	2.0562	221388	1.0000	89.3357
Individual Behavior	Oyibiefye	AF	5830	0.9543	1.4182	243742	0.9882	41.8082
Social Behavior	Oyibiefye	AF	135	0.0221	0.0328	1283	0.0052	9.5037
Interspecific Behavior	Oyibiefye	AF	142	0.0232	0.0345	1610	0.0065	11.3380
Others	Oyibiefye	AF	2	0.0003	0.0005	11	0.0000	5.5000
TOTAL	Oyibiefye	AF	6109	1.0000	1.4861	246646	1.0000	68.1500
Individual Behavior	Peter	SAM	6225	0.9210	1.6795	207742	0.9341	33.3722
Social Behavior	Peter	SAM	431	0.0638	0.1163	13182	0.0593	30.5847
Interspecific Behavior	Peter	SAM	80	0.0118	0.0216	983	0.0044	12.2875
Others	Peter	SAM	23	0.0034	0.0062	482	0.0022	20.9565
TOTAL	Peter	SAM	6759	1.0000	1.8236	222389	1.0000	97.2009
Individual Behavior	Sonja	SAF	5764	0.9222	1.4105	219957	0.8971	38.1605
Social Behavior	Sonja	SAF	279	0.0446	0.0683	22170	0.0904	79.4624
Interspecific Behavior	Sonja	SAF	194	0.0310	0.0475	2859	0.0117	14.7371
Others	Sonja	SAF	13	0.0021	0.0032	197	0.0008	15.1538
TOTAL	Sonja	SAF	6250	1.0000	1.5295	245183	1.0000	147.5138

5. Social Behavior

Table 20: Social behavior type by sex and period

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Trophic	P1	F	2	311	0.2093	0.9994	5324	0.2851	17.1190

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Affiliation	P1	F	2	627	0.4219	2.0149	8637	0.4626	13.7751
Agonistic	P1	F	2	123	0.0828	0.3953	906	0.0485	7.3659
Appeasement	P1	F	2	425	0.2860	1.3658	3804	0.2037	8.9506
TOTAL	P1	F	2	1486	1.0000	4.7753	18671	1.0000	47.2105
Trophic	P2	F	3	9	0.0124	0.0175	960	0.0311	106.6667
Affiliation	P2	F	3	428	0.5912	0.8332	27287	0.8854	0.0000
Agonistic	P2	F	3	131	0.1809	0.2550	902	0.0293	6.8855
Appeasement	P2	F	3	156	0.2155	0.3037	1671	0.0542	0.0000
TOTAL	P2	F	3	724	1.0000	1.4095	30820	1.0000	113.5522
Trophic	P1	M	6	684	0.0922	0.5349	7925	0.1033	11.5863
Affiliation	P1	M	6	4032	0.5434	3.1530	47637	0.6209	11.8147
Agonistic	P1	M	6	1220	0.1644	0.9540	8544	0.1114	7.0033
Appeasement	P1	M	6	1484	0.2000	1.1605	12622	0.1645	8.5054
TOTAL	P1	M	6	7420	1.0000	5.8023	76728	1.0000	38.9097
Trophic	P2	M	6	8	0.0040	0.0090	69	0.0013	0.0000
Affiliation	P2	M	6	1360	0.6824	1.5331	47674	0.8957	35.0544
Agonistic	P2	M	6	387	0.1942	0.4363	2806	0.0527	7.2506
Appeasement	P2	M	6	238	0.1194	0.2683	2676	0.0503	0.0000
TOTAL	P2	M	6	1993	1.0000	2.2467	53225	1.0000	42.3051

Table 21: Social behavior type by housing group and period

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Trophic	P1	1	2	1	0.0012	0.0085	12	0.0017	12.0000
Affiliation	P1	1	2	101	0.1211	0.8610	948	0.1347	9.3861
Agonistic	P1	1	2	224	0.2686	1.9096	1586	0.2253	7.0804
Appeasement	P1	1	2	508	0.6091	4.3308	4492	0.6382	8.8425
TOTAL	P1	1	2	834	1.0000	7.1100	7038	1.0000	37.3090
Trophic	P2	1	3	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	P2	1	3	237	0.3904	1.3121	7758	0.7158	32.7342
Agonistic	P2	1	3	198	0.3262	1.0961	1433	0.1322	7.2374
Appeasement	P2	1	3	172	0.2834	0.9522	1647	0.1520	9.5756
TOTAL	P2	1	3	607	1.0000	3.3604	10838	1.0000	49.5471
Trophic	P1	2	4	730	0.1402	0.7362	10726	0.1803	14.6932
Affiliation	P1	2	4	2776	0.5333	2.7997	35043	0.5890	12.6236
Agonistic	P1	2	4	708	0.1360	0.7140	5176	0.0870	7.3107
Appeasement	P1	2	4	991	0.1904	0.9995	8547	0.1437	8.6246
TOTAL	P1	2	4	5205	1.0000	5.2494	59492	1.0000	43.2521
Trophic	P2	2	4	12	0.0075	0.0129	1010	0.0181	84.1667
Affiliation	P2	2	4	1233	0.7668	1.3229	50898	0.9101	41.2798
Agonistic	P2	2	4	173	0.1076	0.1856	1512	0.0270	8.7399
Appeasement	P2	2	4	190	0.1182	0.2038	2504	0.0448	13.1789
TOTAL	P2	2	4	1608	1.0000	1.7252	55924	1.0000	147.3653
Trophic	P1	3	2	264	0.0921	0.5487	2511	0.0870	9.5114
Affiliation	P1	3	2	1782	0.6216	3.7036	20283	0.7026	11.3822
Agonistic	P1	3	2	411	0.1434	0.8542	2688	0.0931	6.5401
Appeasement	P1	3	2	410	0.1430	0.8521	3387	0.1173	8.2610
TOTAL	P1	3	2	2867	1.0000	5.9586	28869	1.0000	35.6946
Trophic	P2	3	2	5	0.0100	0.0174	19	0.0011	3.8000
Affiliation	P2	3	2	318	0.6335	1.1040	16305	0.9434	51.2736

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Agonistic	P2	3	2	147	0.2928	0.5103	763	0.0441	5.1905
Appeasement	P2	3	2	32	0.0637	0.1111	196	0.0113	6.1250
TOTAL	P2	3	2	502	1.0000	1.7428	17283	1.0000	66.3891

Table 22: Social behavior type by animal during P1

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Trophic	Annan	JM	157	0.1225	0.7503	1459	0.1162	9.2930
Affiliation	Annan	JM	777	0.6061	3.7133	8493	0.6765	10.9305
Agonistic	Annan	JM	142	0.1108	0.6786	994	0.0792	7.0000
Appeasement	Annan	JM	206	0.1607	0.9845	1609	0.1282	7.8107
TOTAL	Annan	JM	1282	1.0000	6.1266	12555	1.0000	35.0342
Trophic	Ape	AM	1	0.0024	0.0163	12	0.0033	12.0000
Affiliation	Ape	AM	47	0.1106	0.7669	686	0.1866	14.5957
Agonistic	Ape	AM	207	0.4871	3.3778	1435	0.3903	6.9324
Appeasement	Ape	AM	170	0.4000	2.7740	1544	0.4199	9.0824
TOTAL	Ape	AM	425	1.0000	6.9350	3677	1.0000	42.6105
Trophic	Ekow	AM	126	0.1015	0.6321	1626	0.1360	12.9048
Affiliation	Ekow	AM	443	0.3570	2.2224	4995	0.4176	11.2754
Agonistic	Ekow	AM	438	0.3529	2.1973	3185	0.2663	7.2717
Appeasement	Ekow	AM	234	0.1886	1.1739	2154	0.1801	9.2051
TOTAL	Ekow	AM	1241	1.0000	6.2258	11960	1.0000	40.6570
Trophic	Mensah	SAM	107	0.0675	0.3935	1052	0.0645	9.8318
Affiliation	Mensah	SAM	1005	0.6341	3.6962	11790	0.7227	11.7313
Agonistic	Mensah	SAM	269	0.1697	0.9893	1694	0.1038	6.2974
Appeasement	Mensah	SAM	204	0.1287	0.7503	1778	0.1090	8.7157
TOTAL	Mensah	SAM	1585	1.0000	5.8293	16314	1.0000	36.5762
Trophic	Nuba	JM	190	0.1280	0.7347	2493	0.1607	13.1211
Affiliation	Nuba	JM	980	0.6604	3.7896	10571	0.6813	10.7867
Agonistic	Nuba	JM	115	0.0775	0.4447	877	0.0565	7.6261
Appeasement	Nuba	JM	199	0.1341	0.7695	1575	0.1015	7.9146
TOTAL	Nuba	JM	1484	1.0000	5.7386	15516	1.0000	39.4484
Trophic	Oyibiefye	AF	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	Oyibiefye	AF	54	0.1320	0.9640	262	0.0780	4.8519
Agonistic	Oyibiefye	AF	17	0.0416	0.3035	151	0.0449	8.8824
Appeasement	Oyibiefye	AF	338	0.8264	6.0339	2948	0.8771	8.7219
TOTAL	Oyibiefye	AF	409	1.0000	7.3014	3361	1.0000	22.4561
Trophic	Peter	SAM	103	0.0734	0.3699	1283	0.0768	12.4563
Affiliation	Peter	SAM	780	0.5560	2.8014	11102	0.6646	14.2333
Agonistic	Peter	SAM	49	0.0349	0.1760	359	0.0215	7.3265
Appeasement	Peter	SAM	471	0.3357	1.6916	3962	0.2372	8.4119
TOTAL	Peter	SAM	1403	1.0000	5.0389	16706	1.0000	42.4281
Trophic	Sonja	SAF	311	0.2888	1.2188	5324	0.3477	17.1190
Affiliation	Sonja	SAF	573	0.5320	2.2456	8375	0.5470	14.6161
Agonistic	Sonja	SAF	106	0.0984	0.4154	755	0.0493	7.1226
Appeasement	Sonja	SAF	87	0.0808	0.3410	856	0.0559	9.8391
TOTAL	Sonja	SAF	1077	1.0000	4.2208	15310	1.0000	48.6967

Table 23: Social behavior type by animal during P2

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Trophic	Accra	AF	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	Accra	AF	169	0.5452	1.3764	6264	0.8503	37.0651
Agonistic	Accra	AF	22	0.0710	0.1792	131	0.0178	5.9545
Appeasement	Accra	AF	119	0.3839	0.9692	972	0.1319	8.1681
TOTAL	Accra	AF	310	1.0000	2.5248	7367	1.0000	51.1877
Trophic	Annan	JM	4	0.0139	0.0218	16	0.0015	4.0000
Affiliation	Annan	JM	198	0.6875	1.0793	10474	0.9516	52.8990
Agonistic	Annan	JM	61	0.2118	0.3325	363	0.0330	5.9508
Appeasement	Annan	JM	25	0.0868	0.1363	154	0.0140	6.1600
TOTAL	Annan	JM	288	1.0000	1.5699	11007	1.0000	69.0098
Trophic	Ape	AM	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	Ape	AM	58	0.3580	1.5905	1342	0.6133	23.1379
Agonistic	Ape	AM	79	0.4877	2.1664	594	0.2715	7.5190
Appeasement	Ape	AM	25	0.1543	0.6856	252	0.1152	10.0800
TOTAL	Ape	AM	162	1.0000	4.4424	2188	1.0000	40.7369
Trophic	Ekow	AM	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	Ekow	AM	167	0.4563	1.2685	5220	0.6608	31.2575
Agonistic	Ekow	AM	122	0.3333	0.9267	1141	0.1444	9.3525
Appeasement	Ekow	AM	77	0.2104	0.5849	1538	0.1947	19.9740
TOTAL	Ekow	AM	366	1.0000	2.7801	7899	1.0000	60.5840
Trophic	Mensah	SAM	1	0.0047	0.0096	3	0.0005	3.0000
Affiliation	Mensah	SAM	120	0.5607	1.1472	5831	0.9291	48.5917
Agonistic	Mensah	SAM	86	0.4019	0.8222	400	0.0637	4.6512
Appeasement	Mensah	SAM	7	0.0327	0.0669	42	0.0067	6.0000
TOTAL	Mensah	SAM	214	1.0000	2.0459	6276	1.0000	62.2428
Trophic	Nuba	JM	2	0.0038	0.0095	35	0.0028	17.5000
Affiliation	Nuba	JM	418	0.7857	1.9790	11827	0.9332	28.2943
Agonistic	Nuba	JM	22	0.0414	0.1042	218	0.0172	9.9091
Appeasement	Nuba	JM	90	0.1692	0.4261	593	0.0468	6.5889
TOTAL	Nuba	JM	532	1.0000	2.5187	12673	1.0000	62.2922
Trophic	Oyibiefye	AF	0	0.0000	0.0000	0	0.0000	0.0000
Affiliation	Oyibiefye	AF	10	0.0741	0.4677	152	0.1185	15.2000
Agonistic	Oyibiefye	AF	97	0.7185	4.5362	708	0.5518	7.2990
Appeasement	Oyibiefye	AF	28	0.2074	1.3094	423	0.3297	15.1071
TOTAL	Oyibiefye	AF	135	1.0000	6.3133	1283	1.0000	37.6061
Trophic	Peter	SAM	1	0.0023	0.0046	15	0.0011	15.0000
Affiliation	Peter	SAM	399	0.9258	1.8161	12980	0.9847	32.5313
Agonistic	Peter	SAM	17	0.0394	0.0774	90	0.0068	5.2941
Appeasement	Peter	SAM	14	0.0325	0.0637	97	0.0074	6.9286
TOTAL	Peter	SAM	431	1.0000	1.9618	13182	1.0000	59.7540
Trophic	Sonja	SAF	9	0.0323	0.0244	960	0.0433	106.6667
Affiliation	Sonja	SAF	249	0.8925	0.6739	20871	0.9414	83.8193
Agonistic	Sonja	SAF	12	0.0430	0.0325	63	0.0028	5.2500
Appeasement	Sonja	SAF	9	0.0323	0.0244	276	0.0124	30.6667
TOTAL	Sonja	SAF	279	1.0000	0.7551	22170	1.0000	226.4026

6. Affiliative behaviors

Table 24: Affiliative behavior type by sex and period

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	P1	F	2	123	0.1962	0.8545	3456	0.4001	28.0976
Physic contact	P1	F	2	195	0.3110	1.3546	2717	0.3146	13.9333
No contact	P1	F	2	111	0.1770	0.7711	913	0.1057	8.2252
Play	P1	F	2	13	0.0207	0.0903	94	0.0109	7.2308
Sex	P1	F	2	185	0.2951	1.2852	1457	0.1687	7.8757
TOTAL	P1	F	2	627	1.0000	4.3557	8637	1.0000	65.3626
Grooming	P2	F	3	151	0.3528	0.3320	20036	0.7343	132.6887
Physic contact	P2	F	3	36	0.0841	0.0792	982	0.0360	27.2778
No contact	P2	F	3	88	0.2056	0.1935	4820	0.1766	54.7727
Play	P2	F	3	6	0.0140	0.0132	69	0.0025	11.5000
Sex	P2	F	3	147	0.3435	0.3232	1380	0.0506	9.3878
TOTAL	P2	F	3	428	1.0000	0.9411	27287	1.0000	235.6270
Grooming	P1	M	6	355	0.0880	0.4471	10652	0.2236	0.0000
Physic contact	P1	M	6	719	0.1783	0.9056	8466	0.1777	11.7747
No contact	P1	M	6	757	0.1877	0.9535	7398	0.1553	9.7728
Play	P1	M	6	1778	0.4410	2.2394	17555	0.3685	0.0000
Sex	P1	M	6	423	0.1049	0.5328	3566	0.0749	8.4303
TOTAL	P1	M	6	4032	1.0000	5.0784	47637	1.0000	29.9777
Grooming	P2	M	6	156	0.1147	0.1963	12906	0.2707	0.0000
Physic contact	P2	M	6	149	0.1096	0.1875	5658	0.1187	37.9732
No contact	P2	M	6	375	0.2757	0.4720	15780	0.3310	42.0800
Play	P2	M	6	535	0.3934	0.6733	10717	0.2248	0.0000
Sex	P2	M	6	145	0.1066	0.1825	2613	0.0548	18.0207
TOTAL	P2	M	6	1360	1.0000	1.7116	47674	1.0000	98.0738

Table 25: Affiliative behavior type by housing group and period

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	P1	1	2	2	0.0198	0.1266	20	0.0211	10.0000
Physic contact	P1	1	2	2	0.0198	0.1266	12	0.0127	6.0000
No contact	P1	1	2	32	0.3168	2.0253	518	0.5464	16.1875
Play	P1	1	2	0	0.0000	0.0000	0	0.0000	0.0000
Sex	P1	1	2	65	0.6436	4.1139	398	0.4198	6.1231
TOTAL	P1	1	2	101	1.0000	6.3924	948	1.0000	38.3106
Grooming	P2	1	3	28	0.1181	0.2166	4233	0.5456	151.1786
Physic contact	P2	1	3	8	0.0338	0.0619	903	0.1164	112.8750
No contact	P2	1	3	30	0.1266	0.2320	888	0.1145	29.6000
Play	P2	1	3	0	0.0000	0.0000	0	0.0000	0.0000
Sex	P2	1	3	171	0.7215	1.3225	1734	0.2235	10.1404
TOTAL	P2	1	3	237	1.0000	1.8329	7758	1.0000	303.7939
Grooming	P1	2	4	270	0.0835	0.4623	8939	0.2551	33.1074
Physic contact	P1	2	4	606	0.1874	1.0376	7011	0.2001	11.5693
No contact	P1	2	4	519	0.1605	0.8886	4917	0.1403	9.4740
Play	P1	2	4	919	1.0000	1.5735	10239	0.2922	11.1415
Sex	P1	2	4	919	0.2843	1.5735	3937	0.1123	4.2840
TOTAL	P1	2	4	3233	1.7157	5.5355	35043	1.0000	69.5762

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	P2	2	4	205	0.1262	0.2417	22705	0.4461	110.7561
Physic contact	P2	2	4	108	0.0665	0.1273	3189	0.0627	29.5278
No contact	P2	2	4	306	0.1883	0.3607	12604	0.2476	41.1895
Play	P2	2	4	503	1.0000	0.5930	10290	0.2022	20.4573
Sex	P2	2	4	503	0.3095	0.5930	2110	0.0415	4.1948
TOTAL	P2	2	4	1625	1.6905	1.9156	50898	1.0000	206.1255
Grooming	P1	3	2	206	0.1156	0.6094	5149	0.2539	24.9951
Physic contact	P1	3	2	306	0.1717	0.9052	4160	0.2051	13.5948
No contact	P1	3	2	317	0.1779	0.9377	2876	0.1418	9.0726
Play	P1	3	2	872	0.4893	2.5795	7410	0.3653	8.4977
Sex	P1	3	2	81	0.0455	0.2396	688	0.0339	8.4938
TOTAL	P1	3	2	1782	1.0000	5.2714	20283	1.0000	64.6540
Grooming	P2	3	2	74	0.2327	0.2723	6004	0.3682	81.1351
Physic contact	P2	3	2	69	0.2170	0.2539	2548	0.1563	36.9275
No contact	P2	3	2	127	0.3994	0.4673	7108	0.4359	55.9685
Play	P2	3	2	38	0.1195	0.1398	496	0.0304	13.0526
Sex	P2	3	2	10	0.0314	0.0368	149	0.0091	14.9000
TOTAL	P2	3	2	318	1.0000	1.1702	16305	1.0000	201.9838

Table 26: Affiliative behavior type by animal during P1

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	Annan	JM	87	0.1120	0.6146	2280	0.2685	26.2069
Physic contact	Annan	JM	130	0.1673	0.9184	1593	0.1876	12.2538
No contact	Annan	JM	171	0.2201	1.2081	1443	0.1699	8.4386
Play	Annan	JM	351	0.4517	2.4797	2883	0.3395	8.2137
Sex	Annan	JM	38	0.0489	0.2685	294	0.0346	7.7368
TOTAL	Annan	JM	777	1.0000	5.4892	8493	1.0000	62.8499
Grooming	Ape	AM	1	0.0213	0.0875	9	0.0131	9.0000
Physic contact	Ape	AM	1	0.0213	0.0875	6	0.0087	6.0000
No contact	Ape	AM	13	0.2766	1.1370	433	0.6312	33.3077
Play	Ape	AM	0	0.0000	0.0000	0	0.0000	0.0000
Sex	Ape	AM	32	0.6809	2.7988	238	0.3469	7.4375
TOTAL	Ape	AM	47	1.0000	4.1108	686	1.0000	55.7452
Grooming	Ekow	AM	32	0.0722	0.3844	773	0.1548	24.1563
Physic contact	Ekow	AM	116	0.2619	1.3934	1169	0.2340	10.0776
No contact	Ekow	AM	159	0.3589	1.9099	1678	0.3359	10.5535
Play	Ekow	AM	18	0.0406	0.2162	111	0.0222	6.1667
Sex	Ekow	AM	118	0.2664	1.4174	1264	0.2531	10.7119
TOTAL	Ekow	AM	443	1.0000	5.3213	4995	1.0000	61.6658
Grooming	Mensah	SAM	119	0.1184	0.6056	2869	0.2433	24.1092
Physic contact	Mensah	SAM	176	0.1751	0.8957	2567	0.2177	14.5852
No contact	Mensah	SAM	146	0.1453	0.7430	1433	0.1215	9.8151
Play	Mensah	SAM	521	0.5184	2.6514	4527	0.3840	8.6891
Sex	Mensah	SAM	43	0.0428	0.2188	394	0.0334	9.1628
TOTAL	Mensah	SAM	1005	1.0000	5.1145	11790	1.0000	66.3614
Grooming	Nuba	JM	52	0.0531	0.2951	1399	0.1323	26.9038
Physic contact	Nuba	JM	198	0.2020	1.1238	2314	0.2189	11.6869
No contact	Nuba	JM	179	0.1827	1.0160	1586	0.1500	8.8603

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Play	Nuba	JM	404	0.4122	2.2931	4227	0.3999	10.4629
Sex	Nuba	JM	147	0.1500	0.8344	1045	0.0989	7.1088
TOTAL	Nuba	JM	980	1.0000	5.5624	10571	1.0000	65.0228
Grooming	Oyibiefye	AF	1	0.0185	0.2290	11	0.0420	11.0000
Physic contact	Oyibiefye	AF	1	0.0185	0.2290	6	0.0229	0.0000
No contact	Oyibiefye	AF	19	0.3519	4.3511	85	0.3244	4.4737
Play	Oyibiefye	AF	0	0.0000	0.0000	0	0.0000	0.0000
Sex	Oyibiefye	AF	33	0.6111	7.5573	160	0.6107	4.8485
TOTAL	Oyibiefye	AF	54	1.0000	12.3664	262	1.0000	20.3222
Grooming	Peter	SAM	64	0.0821	0.3459	3322	0.2992	51.9063
Physic contact	Peter	SAM	98	0.1256	0.5296	817	0.0736	8.3367
No contact	Peter	SAM	89	0.1141	0.4810	825	0.0743	9.2697
Play	Peter	SAM	484	0.6205	2.6157	5807	0.5231	11.9979
Sex	Peter	SAM	45	0.0577	0.2432	331	0.0298	7.3556
TOTAL	Peter	SAM	780	1.0000	4.2155	11102	1.0000	88.8661
Grooming	Sonja	SAF	122	0.2129	0.8740	3445	0.4113	28.2377
Physic contact	Sonja	SAF	194	0.3386	1.3899	2711	0.3237	13.9742
No contact	Sonja	SAF	92	0.1606	0.6591	828	0.0989	9.0000
Play	Sonja	SAF	13	0.0227	0.0931	94	0.0112	7.2308
Sex	Sonja	SAF	152	0.2653	1.0890	1297	0.1549	8.5329
TOTAL	Sonja	SAF	573	1.0000	4.1051	8375	1.0000	66.9756

Table 27: Affiliative behavior type by animal during P2

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	Accra	AF	24	0.1420	0.2299	4162	0.6644	173.4167
Physic contact	Accra	AF	7	0.0414	0.0670	285	0.0455	40.7143
No contact	Accra	AF	19	0.1124	0.1820	674	0.1076	35.4737
Play	Accra	AF	0	0.0000	0.0000	0	0.0000	0.0000
Sex	Accra	AF	119	0.7041	1.1398	1143	0.1825	9.6050
TOTAL	Accra	AF	169	1.0000	0.4789	6264	1.0000	249.6046
Grooming	Annan	JM	47	0.2374	0.2692	4690	0.4478	99.7872
Physic contact	Annan	JM	44	0.2222	0.2521	1927	0.1840	43.7955
No contact	Annan	JM	77	0.3889	0.4411	3475	0.3318	45.1299
Play	Annan	JM	26	0.1313	0.1489	360	0.0344	13.8462
Sex	Annan	JM	4	0.0202	0.0229	22	0.0021	5.5000
TOTAL	Annan	JM	198	1.0000	1.1342	10474	1.0000	208.0587
Grooming	Ape	AM	3	0.0517	0.1341	38	0.0283	12.6667
Physic contact	Ape	AM	1	0.0172	0.0447	618	0.4605	618.0000
No contact	Ape	AM	8	0.1379	0.3577	161	0.1200	20.1250
Play	Ape	AM	0	0.0000	0.0000	0	0.0000	0.0000
Sex	Ape	AM	46	0.7931	2.0566	525	0.3912	11.4130
TOTAL	Ape	AM	58	1.0000	2.5931	1342	1.0000	662.2047
Grooming	Ekow	AM	5	0.0299	0.0575	222	0.0425	44.4000
Physic contact	Ekow	AM	29	0.1737	0.3333	537	0.1029	18.5172
No contact	Ekow	AM	83	0.4970	0.9540	2860	0.5479	34.4578
Play	Ekow	AM	1	0.0060	0.0115	30	0.0057	30.0000
Sex	Ekow	AM	49	0.2934	0.5632	1571	0.3010	32.0612
TOTAL	Ekow	AM	167	1.0000	1.9195	5220	1.0000	159.4363

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Grooming	Mensah	SAM	27	0.2250	0.2778	1314	0.2253	48.6667
Physic contact	Mensah	SAM	25	0.2083	0.2572	621	0.1065	24.8400
No contact	Mensah	SAM	50	0.4167	0.5145	3633	0.6230	72.6600
Play	Mensah	SAM	12	0.1000	0.1235	136	0.0233	11.3333
Sex	Mensah	SAM	6	0.0500	0.0617	127	0.0218	21.1667
TOTAL	Mensah	SAM	120	1.0000	1.2348	5831	1.0000	178.6667
Grooming	Nuba	JM	36	0.0861	0.1826	3033	0.2564	84.2500
Physic contact	Nuba	JM	23	0.0550	0.1167	872	0.0737	37.9130
No contact	Nuba	JM	62	0.1483	0.3145	1738	0.1470	28.0323
Play	Nuba	JM	286	0.6842	1.4509	6102	0.5159	21.3357
Sex	Nuba	JM	11	0.0263	0.0558	82	0.0069	7.4545
TOTAL	Nuba	JM	418	1.0000	2.1206	11827	1.0000	178.9855
Grooming	Oyibiefye	AF	1	0.1000	0.3947	33	0.2171	33.0000
Physic contact	Oyibiefye	AF	0	0.0000	0.0000	0	0.0000	0.0000
No contact	Oyibiefye	AF	3	0.3000	1.1842	53	0.3487	17.6667
Play	Oyibiefye	AF	0	0.0000	0.0000	0	0.0000	0.0000
Sex	Oyibiefye	AF	6	0.6000	2.3684	66	0.4342	11.0000
TOTAL	Oyibiefye	AF	10	1.0000	3.9474	152	1.0000	61.6667
Grooming	Peter	SAM	38	0.0952	0.1757	3609	0.2780	94.9737
Physic contact	Peter	SAM	27	0.0677	0.1248	1083	0.0834	40.1111
No contact	Peter	SAM	95	0.2381	0.4391	3913	0.3015	41.1895
Play	Peter	SAM	210	0.5263	0.9707	4089	0.3150	19.4714
Sex	Peter	SAM	29	0.0727	0.1341	286	0.0220	9.8621
TOTAL	Peter	SAM	399	1.0000	1.8444	12980	1.0000	205.6078
Grooming	Sonja	SAF	126	0.5060	0.3622	15841	0.7590	125.7222
Physic contact	Sonja	SAF	29	0.1165	0.0834	697	0.0334	24.0345
No contact	Sonja	SAF	66	0.2651	0.1897	4093	0.1961	62.0152
Play	Sonja	SAF	6	0.0241	0.0172	69	0.0033	11.5000
Sex	Sonja	SAF	22	0.0884	0.0632	171	0.0082	7.7727
TOTAL	Sonja	SAF	249	1.0000	0.7158	20871	1.0000	231.0446

7. Agonist behaviors

Table 28: Agonistic behavior type by sex and period

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Direct threat	P1	F	2	58	0.4715	3.8411	392	0.4327	6.7586
Indirect threat	P1	F	2	24	0.1951	1.5894	196	0.2163	0.0000
Attack	P1	F	2	41	0.3333	2.7152	318	0.3510	7.7561
TOTAL	P1	F	2	123	1.0000	8.1457	906	1.0000	14.5147
Direct threat	P2	F	3	165	0.7857	6.7439	1262	0.8597	7.6485
Indirect threat	P2	F	3	9	0.0429	0.3678	22	0.0150	0.0000
Attack	P2	F	3	36	0.1714	1.4714	184	0.1253	5.1111
TOTAL	P2	F	3	210	1.0000	8.5831	1468	1.0000	12.7596
Direct threat	P1	M	6	627	0.5139	4.4031	4620	0.5407	0.0000
Indirect threat	P1	M	6	247	0.2025	1.7346	1549	0.1813	6.2713
Attack	P1	M	6	346	0.2836	2.4298	2375	0.2780	6.8642
TOTAL	P1	M	6	1220	1.0000	8.5674	8544	1.0000	13.1354
Direct threat	P2	M	6	115	0.2972	2.4590	1079	0.3845	0.0000
Indirect threat	P2	M	6	146	0.3773	3.1219	747	0.2662	5.1164

	Period	Sex	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Attack	P2	M	6	126	0.3256	2.6942	980	0.3493	7.7778
TOTAL	P2	M	6	387	1.0000	8.2751	2806	1.0000	12.8942

Table 29: Agonistic behavior type by housing group and period

	Period	Group	n	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Direct threat	P1	1	2	181	0.8080	6.8474	1249	0.7875	6.9006
Indirect threat	P1	1	2	16	0.0714	0.6053	125	0.0788	7.8125
Attack	P1	1	2	27	0.1205	1.0214	212	0.1337	7.8519
TOTAL	P1	1	2	224	1.0000	8.4741	1586	1.0000	22.5649
Direct threat	P2	1	3	193	0.6968	5.7929	1542	0.7714	7.9896
Indirect threat	P2	1	3	28	0.1011	0.8404	157	0.0785	5.6071
Attack	P2	1	3	56	0.2022	1.6808	300	0.1501	5.3571
TOTAL	P2	1	3	277	1.0000	8.3142	1999	1.0000	18.9539
Direct threat	P1	2	4	358	0.5056	4.1499	2763	0.5338	7.7179
Indirect threat	P1	2	4	116	0.1638	1.3447	731	0.1412	6.3017
Attack	P1	2	4	234	0.3305	2.7125	1682	0.3250	7.1880
TOTAL	P1	2	4	708	1.0000	8.2071	5176	1.0000	21.2076
Direct threat	P2	2	4	64	0.3699	2.5397	656	0.4339	10.2500
Indirect threat	P2	2	4	24	0.1387	0.9524	97	0.0642	4.0417
Attack	P2	2	4	85	0.4913	3.3730	759	0.5020	8.9294
TOTAL	P2	2	4	173	1.0000	6.8651	1512	1.0000	23.2211
Direct threat	P1	3	2	146	0.3552	3.2589	1000	0.3720	6.8493
Indirect threat	P1	3	2	139	0.3382	3.1027	889	0.3307	6.3957
Attack	P1	3	2	126	0.3066	2.8125	799	0.2972	6.3413
TOTAL	P1	3	2	411	1.0000	9.1741	2688	1.0000	19.5863
Direct threat	P2	3	2	23	0.1565	1.8087	143	0.1874	6.2174
Indirect threat	P2	3	2	103	0.7007	8.0996	515	0.6750	5.0000
Attack	P2	3	2	21	0.1429	1.6514	105	0.1376	5.0000
TOTAL	P2	3	2	147	1.0000	11.5596	763	1.0000	16.2174

Table 30: Agonistic behavior type by animal during P1

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Direct threat	Annan	JM	34	0.2394	2.0523	283	0.2847	8.3235
Indirect threat	Annan	JM	54	0.3803	3.2596	391	0.3934	7.2407
Attack	Annan	JM	54	0.3803	3.2596	320	0.3219	5.9259
TOTAL	Annan	JM	142	1.0000	8.5714	994	1.0000	21.4902
Direct threat	Ape	AM	167	0.8068	6.9826	1133	0.7895	6.7844
Indirect threat	Ape	AM	15	0.0725	0.6272	103	0.0718	6.8667
Attack	Ape	AM	25	0.1208	1.0453	199	0.1387	7.9600
TOTAL	Ape	AM	207	1.0000	8.6551	1435	1.0000	21.6111
Direct threat	Ekow	AM	277	0.6324	5.2182	2133	0.6697	7.7004
Indirect threat	Ekow	AM	7	0.0160	0.1319	48	0.0151	6.8571
Attack	Ekow	AM	154	0.3516	2.9011	1004	0.3152	6.5195
TOTAL	Ekow	AM	438	1.0000	8.2512	3185	1.0000	21.0770
Direct threat	Mensah	SAM	112	0.4164	3.9669	717	0.4233	6.4018

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Indirect threat	Mensah	SAM	85	0.3160	3.0106	498	0.2940	5.8588
Attack	Mensah	SAM	72	0.2677	2.5502	479	0.2828	6.6528
TOTAL	Mensah	SAM	269	1.0000	9.5277	1694	1.0000	18.9134
Direct threat	Nuba	JM	28	0.2435	1.9156	294	0.3352	10.5000
Indirect threat	Nuba	JM	54	0.4696	3.6944	326	0.3717	6.0370
Attack	Nuba	JM	33	0.2870	2.2577	257	0.2930	7.7879
TOTAL	Nuba	JM	115	1.0000	7.8677	877	1.0000	24.3249
Direct threat	Oyibiefye	AF	14	0.8235	5.5629	116	0.7682	8.2857
Indirect threat	Oyibiefye	AF	1	0.0588	0.3974	22	0.1457	22.0000
Attack	Oyibiefye	AF	2	0.1176	0.7947	13	0.0861	6.5000
TOTAL	Oyibiefye	AF	17	1.0000	6.7550	151	1.0000	36.7857
Direct threat	Peter	SAM	9	0.1837	1.5042	60	0.1671	6.6667
Indirect threat	Peter	SAM	32	0.6531	5.3482	183	0.5097	5.7188
Attack	Peter	SAM	8	0.1633	1.3370	116	0.3231	14.5000
TOTAL	Peter	SAM	49	1.0000	8.1894	359	1.0000	26.8854
Direct threat	Sonja	SAF	44	0.4151	3.4967	276	0.3656	6.2727
Indirect threat	Sonja	SAF	23	0.2170	1.8278	174	0.2305	7.5652
Attack	Sonja	SAF	39	0.3679	3.0993	305	0.4040	7.8205
TOTAL	Sonja	SAF	106	1.0000	8.4238	755	1.0000	21.6585

Table 31: Agonistic behavior type by animal during P2

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
Direct threat	Accra	AF	94	0.9307	8.0918	629	0.9024	6.6915
Indirect threat	Accra	AF	0	0.0000	0.0000	0	0.0000	0.0000
Attack	Accra	AF	7	0.0693	0.6026	68	0.0976	9.7143
TOTAL	Accra	AF	101	1.0000	8.6944	697	1.0000	16.4058
Direct threat	Annan	JM	11	0.1803	1.8182	69	0.1901	6.2727
Indirect threat	Annan	JM	47	0.7705	7.7686	272	0.7493	5.7872
Attack	Annan	JM	3	0.0492	0.4959	22	0.0606	7.3333
TOTAL	Annan	JM	61	1.0000	10.0826	363	1.0000	19.3933
Direct threat	Ape	AM	29	0.3671	2.9293	304	0.5118	10.4828
Indirect threat	Ape	AM	27	0.3418	2.7273	153	0.2576	5.6667
Attack	Ape	AM	23	0.2911	2.3232	137	0.2306	5.9565
TOTAL	Ape	AM	79	1.0000	7.9798	594	1.0000	22.1059
Direct threat	Ekow	AM	40	0.3279	2.1034	416	0.3646	10.4000
Indirect threat	Ekow	AM	3	0.0246	0.1578	9	0.0079	3.0000
Attack	Ekow	AM	79	0.6475	4.1543	716	0.6275	9.0633
TOTAL	Ekow	AM	122	1.0000	6.4154	1141	1.0000	22.4633
Direct threat	Mensah	SAM	12	0.1395	1.8000	74	0.1850	6.1667
Indirect threat	Mensah	SAM	56	0.6512	8.4000	243	0.6075	4.3393
Attack	Mensah	SAM	18	0.2093	2.7000	83	0.2075	4.6111
TOTAL	Mensah	SAM	86	1.0000	12.9000	400	1.0000	15.1171
Direct threat	Nuba	JM	10	0.4545	2.7523	133	0.6101	13.3000
Indirect threat	Nuba	JM	10	0.4545	2.7523	65	0.2982	6.5000
Attack	Nuba	JM	2	0.0909	0.5505	20	0.0917	10.0000
TOTAL	Nuba	JM	22	1.0000	6.0550	218	1.0000	29.8000
Direct threat	Oyibiefye	AF	70	0.7216	5.9322	609	0.8602	8.7000
Indirect threat	Oyibiefye	AF	1	0.0103	0.0847	4	0.0056	4.0000
Attack	Oyibiefye	AF	26	0.2680	2.2034	95	0.1342	3.6538

	Animal	Age/Sex	Frequency	Relative frequency	Tax	Duration (s)	Relative duration	Mean duration (s)
TOTAL	Oyibiefye	AF	97	1.0000	8.2203	708	1.0000	16.3538
Direct threat	Peter	SAM	13	0.7647	8.6667	83	0.9222	6.3846
Indirect threat	Peter	SAM	3	0.1765	2.0000	5	0.0556	1.6667
Attack	Peter	SAM	1	0.0588	0.6667	2	0.0222	2.0000
TOTAL	Peter	SAM	17	1.0000	11.3333	90	1.0000	10.0513
Direct threat	Sonja	SAF	1	0.0833	0.9524	24	0.3810	24.0000
Indirect threat	Sonja	SAF	8	0.6667	7.6190	18	0.2857	2.2500
Attack	Sonja	SAF	3	0.2500	2.8571	21	0.3333	7.0000
TOTAL	Sonja	SAF	12	1.0000	11.4286	63	1.0000	33.2500

8. Group dominance hierarchy sociometric matrices

Table 32: Sociometric matrix table of place impersonation events in group 1 during P1

Emitter	Receiver	
	Ape	Oyibiefye
Ape		1
Oyibiefye	0	

Table 33: Sociometric matrix table of place impersonation events in group 2 during P1

Emitter	Receiver			
	Ekow	Sonja	Nuba	Peter
Ekow		3	10	4
Sonja	0		1	7
Nuba	0	5		17
Peter	0	0	0	

Table 34: Sociometric matrix table of place impersonation events in group 3 during P1

Emitter	Receiver	
	Mensah	Annan
Mensah		17
Annan	2	

9. Affiliative sociometric matrix

Table 35: Sociometric matrix table of affiliative behaviors in group 1 during P1

Emitter	Receiver		TOTAL
	Ape	Oyibiefye	
Ape		42	42
Oyibiefye	54		54
TOTAL	54	42	

Table 36: Sociometric matrix table of affiliative behaviors in group 1 during P2

Emitter	Receiver			TOTAL
	Ape	Oybiefye	Accra	
Ape		2	74	76
Oybiefye	3		10	13
Accra	116	28		144
TOTAL	119	30	84	

Table 37: Sociometric matrix table of affiliative behaviors in group 2 during P1

Emitter	Receiver				TOTAL
	Ekow	Sonja	Nuba	Peter	
Ekow		209	102	60	371
Sonja	106		167	72	245
Nuba	114	260		351	725
Peter	45	106	320		471
TOTAL	265	575	489	483	

Table 38: Sociometric matrix table of affiliative behaviors in group 2 during P2

Emitter	Receiver				TOTAL
	Ekow	Sonja	Nuba	Peter	
Ekow		83	42	17	142
Sonja	76		40	36	152
Nuba	5	75		127	207
Peter	54	95	128		278
TOTAL	135	253	210	180	

Table 39: Sociometric matrix table of affiliative behaviors in group 3 during P1

Emitter	Receiver		TOTAL
	Annan	Mensah	
Annan		928	928
Mensah	689		689
TOTAL	689	928	

Table 40: Sociometric matrix table of affiliative behaviors in group 3 during P

Emitter	Receiver		TOTAL
	Annan	Mensah	
Annan		189	189
Mensah	111		111
TOTAL	111	189	

10. Displacement sociometric matrix

Table 41: Sociometric matrix table of SPS events in group 2 during P1

Emitter	Receiver			
	Ekow	Sonja	Nuba	Peter
Ekow		0	2	0
Sonja	0		1	0
Nuba	0	0		26
Peter	0	2	0	

11. Agonistic sociometric matrix

Table 42: Sociometric matrix table of agonistic behaviors during P1

Emitter	Receiver								TOTAL
	Ape	Oybiefyte	Nuba	Ekow	Peter	Sonja	Annan	Mensah	
Ape		21							21
Oybiefyte	4								4
Nuba				11	63	25			99
Ekow			38		320	13			371
Peter			6	1		4			11
Sonja			17	4	57				78
Annan								20	20
Mensah							59		59
TOTAL	4	21	61	16	440	42	59	20	

Table 43: Sociometric matrix table of agonistic behaviors during P2

Emitter	Receiver									TOTAL
	Accra	Ape	Oybiefyte	Nuba	Ekow	Peter	Sonja	Annan	Mensah	
Accra		2	91			1	2			96
Ape	53		8		1					62
Oybiefyte	89	2								91
Nuba	3		1		10	0	0			14
Ekow	8			107		3	0	1		119
Peter	4		3	5	0		3			15
Sonja	1		1	0	0	2				4
Annan									2	2
Mensah								23		23
TOTAL	158	4	104	112	11	6	5	24	2	