Nonhuman Primate Behavior in Mixed Species Exhibit: Wolf's Guenons and Drill Monkey (*Cercopithecus wolfi* and *Mandrillus leucophaeus*)

Sumbul M. Siddiqui

Ella R. Brown

Bonnie M. Perdue

Agnes Scott College

Abstract

While evidence suggests that forming mixed species exhibits can be difficult, several mixed species of nonhuman primates have been observed to be successful. Interspecies associations can result in stressful interactions, leading to aggression. It is rare to have detailed data on which primate species are compatible with each other. Even though some primate species have been documented to coexist with each other, Wolf's Guenon *Cercopithecus wolfi* and Drill Monkeys *Mandrillus leucophaeus* have not been studied intensively. This study aims to understand the relationship of interspecies behavior and aggression and social proximity between both primates. Animal sampling method of instantaneous occurrence was used to record observations of 2 *C. wolfi* (brother and sister) and 2 *M. leucophaeus* (both sisters) during 30 seconds sessions over a period of six days. An independent t- test was conducted for animal and aggressive behavior between the species as well as the frequency of zone preference. Analysis of data demonstrated no significant aggressive behavior in both species; however other behaviors indicated significant results, including preference for arboreal or ground space. These factors may contribute to the peaceful co-existence of the *C. wolfi* and *M. leucophaeus* at the Atlanta Zoo.

Keywords: Wolf's guenon; Drill Monkey; Cercopithecus wolfi; Mandrillus leucophaeus; aggressive behavior; social proximity; mixed species exhibit; welfare

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The zoo environment for species may be categorized in terms of regular presence of unfamiliar humans, restricted space, enrichment activities, and welfare management. Yet, zoo primates are also maintained in mixed species groups, which they may or may not encounter in their natural environment. Even though mixed species groupings can also occur in the wild, groups must be monitored carefully to ensure that interspecific aggression, which can indicate indirect stress expressed by social dominance rather than explicit aggression, is not proving hazardous to the welfare of the animals (Daltoni & Buchanan-Smith, 2005). Primates will avoid the harmful effects of aggression through means as reconciliation, consolation, and avoidance (Hosey, 2005). This allows captive groups to live somewhat peacefully in restricted space. Although efforts are commonly made to provide environmental enrichment for captive primates, social enrichment is relatively neglected because it is not straightforward or risk-free. Housing different species together may be one way to enrich them socially. The benefits and potential risks of a list of mixed species exhibits as well as how to minimize or avoid such risks can be found in the literature review of Buchanan-Smith (2012). It can also be beneficial for zoos when species are below their natural group sizes.

The primary advantage of mixed species exhibits is environmental enrichment. This leads to improved psychological well-being and raises activity levels and social complexity (Daltoni & Buchanan-Smith, 2005). The increased activity found in mixed species troop reflects higher levels of both physical and psychological stimulation. Mixed species groups may also benefit from being housed in a bigger enclosure (Leonardi, Buchanan-Smith, Dufour, MacDonald, & Whiten, 2010). Mixed species exhibits allow several species to be managed within one enclosure space. For instance, arboreal species can be mixed with terrestrial species, each using different

levels of the available space, or diurnal and nocturnal species can share an exhibit (Dorman & Bourne, 2010). Leonardi, Buchanan-Smith, Dufour, MacDonald, and Whiten (2010) presented a study on the behavior of single and mixed species groups of capuchin and squirrel monkeys. Even though all occurrences of intraspecific aggression and interspecific interactions were recorded, their data suggested that in carefully designed large enclosures, monkeys are able to live harmoniously and are enriched by each other. In another similar study, Daltoni and Buchanan-Smith (2005) examined the differences in the enclosure use and discovered the compatibility of Goeldi's monkeys and Pygmy marmosets. Therefore, the social complexities in mixed species enclosures provide a more natural environment for species to interact as they would in their respective ecological niche.

Even though influences such as enclosure size, method of introduction, group composition, and choice of species contribute to the welfare of the mixed species, individual personalities or changing social dynamics may bring about the failure of a mixed species exhibit, even after a long period of success (Daltoni & Buchanan-Smith, 2005). While mixed species exhibits may bring together species that share natural environments, they enforce closer associations than would naturally occur (Dorman & Bourne, 2010). Potential health problems associated with mixed exhibits can also occur. Injuries occur because of interspecific aggression such as self-inflicted injuries when an individual of one species escapes from another species, transmission of disease between species, and nutritional problems if one species eats the incorrect diet intended for another species. Even when physical injury does not occur, dominant species may taunt other species and cause extreme stress (Dorman & Bourne, 2010). Determining what factors contribute to success can be challenging because it is not common that detailed data are available for different species (Daltoni & Buchanan-Smith, 2005). A good

knowledge of the behavioral biology of the species in their natural environment is needed before undertaking such social manipulations in mixed species exhibits.

Aggressive Behavior and Social Proximity

Primates are considered difficult to assimilate with other species because they are not only aggressively territorial but also because they are inquisitive creatures that they tend to make other species apprehensive (Casares, Recuero, & Fernandez-Hoyo, 2011). Aggressive behavior demonstrates in a number of situations in primates: intergroup resource defense, anti-predator behavior, predation, and intragroup social contexts such as dominance contests and reproduction. Pathological self-directed aggressive behavior such as self-injurious behaviors can also occur (Honess & Marin, 2006). While poorly distributed enrichment may encourage aggressive competition, enrichment that is species, sex, age, and background appropriate can dramatically decrease aggression. The best way to improve a primate's psychological well-being is to provide it with a partner or place it in an appropriate social group, preferably conspecific. This enables it to express at least some natural social behavior. Although evidence suggests that forming mixed species groups can be problematic and lead to substantial problems. Thus, pairing amongst primates should be carefully considered (Honess & Marin, 2006). Casares, Recuero, and Fernandez-Hoyo (2011) recorded the aggressive behaviors in the population of Talapoin monkeys in mixed species exhibits in European zoos. They discovered that although the primates benefit from the larger space available in such enclosures, incidental fatality as a result of conflicts with other Old World primate species nevertheless occurred. However, some primates will simply coexist with the other animals by separating themselves such as vertical separation or being active at different times and without any direct interaction. These species are likely to make appropriate enclosure cohabitants (Buchanan-Smith, 2012). Therefore, these species can

avoid any interspecific aggression by separating themselves into their own natural habitat. One species may also initiate interaction while the other responds submissively, which can be seen in Daltoni and Buchanan-Smith's (2005) study of Goeldi's monkeys and Pygmy marmosets.

Wolf's Guenon and Drill Monkey

Wolf's guenons, or *Cercopithecus wolfi,* breed in the rainforests and swamp forests and can be found in Congo, Rwanda, and Uganda. These primates can grow to about sixty inches from head to tail. The males tend to be larger and weigh more than the females. The average weight is 2.7 kg to 4.1 kg (Zoo Atlanta). They will feed on fruit, leaves, flowers, nectar, and insects. *C. wolfi* have also been seen to form mixed-species groups with Schmidt's guenons and other types of monkeys in the wild. They probably form these groups to decrease the risk of predation. Despite this, *C. wolfi* populations have significantly decreased due to habitat loss and illegal bushmeat trade (Zoo Atlanta).

Just like the *C. wolfi*, the Drill monkeys, or *Mandrillus leucophaeus,* populations have also decreased; however, these diurnal primates are more significantly endangered. The males will weigh about 20.0 kg, and the females will weigh about 12.7 kg (Zoo Atlanta). The *M. leucophaeus* are found in the primary forests in Cameroon and Nigeria and on the island of Bioko, Equatorial Guinea. They also like to eat fruit, insects, and plants. They live in large social groups with one dominant leader. These groups can also merge with other groups. *M. leucophaeus* will use facial expression and a wide range of vocal, olfactory, visual, and tactile forms of communication to keep their group together as well as to keep others away. They mark their territory by rubbing their chests on trees. Because their numbers have been continuously declining, *M. leucophaeus* are protected by law and conservation efforts are in place (Zoo Atlanta).

Purpose

The current research is focused on the effects of behavior in mixed species exhibits. Particularly, by examining the differences in the enclosure use (zone location) as well as behavior in both single and mixed species groups, it will be possible to determine if either species avoids or is dissuaded from particular zones by the other species. It is hypothesized that there will be a positive association between aggressive behavior and interspecies social proximity. By evaluating these interactions, it will also be possible to determine if degrees of aggression or animal behavior between the *C. wolfi* and *M. leucophaeus* are a cause for welfare concern in a captive environment.

Method

Subjects

Data was collected on *C. wolfi* and *M. leucophaeus* on display at the Zoo Atlanta in Atlanta, Georgia. Permission to observe the primates was granted by Zoo Atlanta. The captive primates are located in two yards; however, yard 1 was only studied. Yard 1 consists of two *C. wolfi* (brother and sister) and two *M. leucophaeus* (sisters).

Materials

An iPhone 5 was used as an interval timer, which was provided by Ella R. Brown. An app called Interval Timer was used to signal an alert when the 30-seconds for each sampling scan began and ended. A view of yard 1 is photographed and divided into four zones in order to keep track of where each primate was. The observers also carried with them data sheets, a clipboard, and a writing utensil in order to record observations.

Procedure

In order to examine whether social proximity has an effect on aggressive behavior in *C. wolfi* and *M. leucophaeus*, data was collected by two student observers at the exhibit every Thursday (n=6) from 3:30-4:30 between October and November 2014. Behavior was recorded using instantaneous occurrence as animal sampling method. One student observer recorded the behavioral states of each primate while the other student recorded which zone the primate was in.

Instantaneous sampling at 30-second intervals was used to record behavioral states. During each 30-second time period, when the iPhone signaled an alert, the primate's behavior was recorded, using the appropriate behavioral code from the ethogram (Appendix) in the column on the instantaneous section of the data sheet (Table 1). Instantaneous sampling was also used to record which zone the primates was in (Table 2).

Statistics

An independent t-test was conducted in order to examine for any significant behavior and social proximity. A bar graph was made in order to demonstrate the comparison of behavior and zone location of both species.

Results

Observed Behaviors

There was no significant aggressive behavior observed between both species in any zone location. An analysis through an independent t-test could not be conducted due to the lack of aggressive behavior in *C. wolfi*. Yet, there were some prominent behaviors seen in the species (Figure 2). *C. wolfi* spent most of their time in locomotion, resting, self-directed behavior, and social grooming. *M. leucophaeus* were seen in feeding, locomotion, object-directed behavior, resting, and self-directed behavior.

M. leucophaeus were observed to demonstrate behaviors more frequently than the *C. wolfi*. *M. leucophaeus* spent more time feeding (M=2.88, SD=3.64) than *C. wolfi* (M=0.12, SD=0.33); t(32)=3.12, p=0.004. *M. leucophaeus* favored locomotive behavior (M=6.88, SD=4.27) than the *C. wolfi* (M=2.35, SD=2.06); t(32)=3.94, p< 0.001. *M. leucophaeus* also performed more object-directed behavior (M=0.75, SD=0.97) than the *C. wolfi* (M=0.12, SD=0.33); t(32)=2.61, p=0.014. Conversely, the *C. wolfi* preferred only one behavior, which was actively behaving in social grooming (M=7.29, SD=8.13) than the *M. leucophaeus* (M=0.12, SD=0.49); t(32)=-3.62, p=0.001.

Zone Locations

The yard of the species was divided into four zones, which can be seen in Figure 1. An independent t-test revealed no difference in zone preference in both species. The primates demonstrated no significant choice of preference over the other species:

1. Zone 1: *M. leucophaeus* (M=0.06, SD=0.24) and *C. wolfi* (M=0.12, SD=0.49) demonstrated no significant choice of preference; t(32)=-0.45, p=0.658.
2. Zone 2: *M. leucophaeus* (M=8.24, SD=7.57) demonstrated no significance in choice over the *C. wolfi* (M=4.29, SD=7.50); t(32)=1.53, p=0.137.
3. Zone 3: *M. leucophaeus* (M=0.35, SD=0.86) did not demonstrate any significant preference over the *C. wolfi*. (M=0.94, SD=1.98); t(32)=-1.12, p=0.270.
4. Zone 4: *M. leucophaeus* (M=9.64, SD=7.54) did not indicate preference over the *C. wolfi* (M=13.06, SD=7.07); t(32)=-1.36, p=0.183.

Both of the monkeys were also recorded when they were not visible to the observers, and the *M. leucophaeus* (M=1.71, SD=3.65) demonstrated the same frequency of no visibility as the *C. wolfi* (M=1.59, SD=3.34); t(32)=0.98, p=0.923). However, both species tended to prefer zones 2 and 4

overall (Figure 3). The species were also noted for their ground and arboreal preference. There was a significant result for ground preference for the *M. leucophaeus* (M=7.53, SD=6.80) than the *C. wolfi* (M=4.43, SD=4.43); t(32)=2.15, p=0.039. There was no significance in arboreal preference for the *M. leucophaeus* (M=10.76; SD=8.33) than the *C. wolfi* (M=15.12, SD=4.83); t(32)=-1.86, p=0.072. Yet, the *C. wolfi* seemed to prefer the arboreal areas (Figure 4).

Discussion

The benefits to keep a mixed species exhibit involve the use of social and environmental enrichment in order to create a more realistic and natural experience. Several species can be managed in one space. Visitors can also learn and observe how animals interact in their captive environment.

The Zoo Atlanta housing of the *C. wolfi* and *M. leucophaeus* seem to provide good welfare for both species. While nonhuman primates are known to be aggressively territorial (Casares, Recuero, & Fernandez-Hoyo, 2011), the *C. wolfi* and *M. leucophaeus* did not demonstrate any significant aggressive behavior or stereotypical behaviors due to stress or restricted captivity. Although the *M. leucophaeus* initiated the non-contact aggressive behavior while the *C. wolfi* avoided contact. This indicates that the *C. wolfi* were the submissive species in the yard while the *M. leucophaeus* were prominently dominant. Daltoni and Buchanan-Smith's (2005) study of Goeldi's monkeys and Pygmy marmosets indicates that one species will responds submissively in order to avoid interspecific aggression. Both species also demonstrated some variability in behavior, probably displaying their natural social behavior.

One of the most important characteristics of a mixed-species exhibit is the enclosure space. Dorman and Bourne (2010) argue that arboreal and terrestrial species can be in a mixed species exhibit because each species will be using different levels of the available space. This

can be seen in the interactions of the *C. wolfi* and *M. leucophaeus*. While both species are arboreal, the *C. wolfi* seemed to significantly prefer the arboreal space than the ground. *M. leucophaeus* were often seen locomotive in the ground as well. The *M. leucophaeus* were only arboreal on the high rocks while the *C. wolfi* preferred either the high rocks or the trees. An interesting note is that both species tended to stay in zones 2 and 4. There needs to be a more data collected on why half the yard is preferred. It could be due to the high rocks in both zones 2 and 4. There is also a camouflaged door or entrance for a zookeeper to enter the yard in zone 4, possibly indicating how a zookeeper enters to provide food. This could also explain the preference for zone 4 as the primates anticipated for their dietary needs.

There were limitations to this study. The monkeys were not visible in certain areas of the yard; however, both species seemed to have spent the same amount of time not visible. Thus, there was no significant difference. This usually occurred in the bottom and high corners of zone 4 as the primates hid behind rocks or in the canopy on the roof from the observers' plain view. The yard 1 was also located next to yard 2. In one day of observation, the primates seemed to be highly intrigued on what was occurring in the next yard or over the fence in zone 2. This could also indicate the preference for zone 2. There also needs to be a larger sample size for a better analysis of data. The behaviors of the monkeys were also not recorded in the last two sessions because the monkeys were off-exhibit.

Overall, the primates were not bothered by the other species. There were no stereotypical or aggressive behaviors observed. The compatible for the two species in this study indicates that one species should prefer the ground or arboreal space. One species should also be naturally submissive or dominant in order to avoid any aggressive stances from the other species. Further studies could also indicate that aggressive behavior did not occur due to lack of sexual

competition. Because both species did not need to sexually compete with each other, interspecific aggression was avoided. It should be noted that the *M. leucophaeus* were both females while the more submissive *C. wolfi* were male and female. These could also be the underlying factors incorporated into forming a mixed-species exhibit in order to stimulate a compatible, enriching atmosphere amongst primates and to promote proper social welfare.

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Figure 1. Zone Locations: Photographic image of captive environment in Zoo Atlanta for *C. wolfi* and *M. leucophaeus*

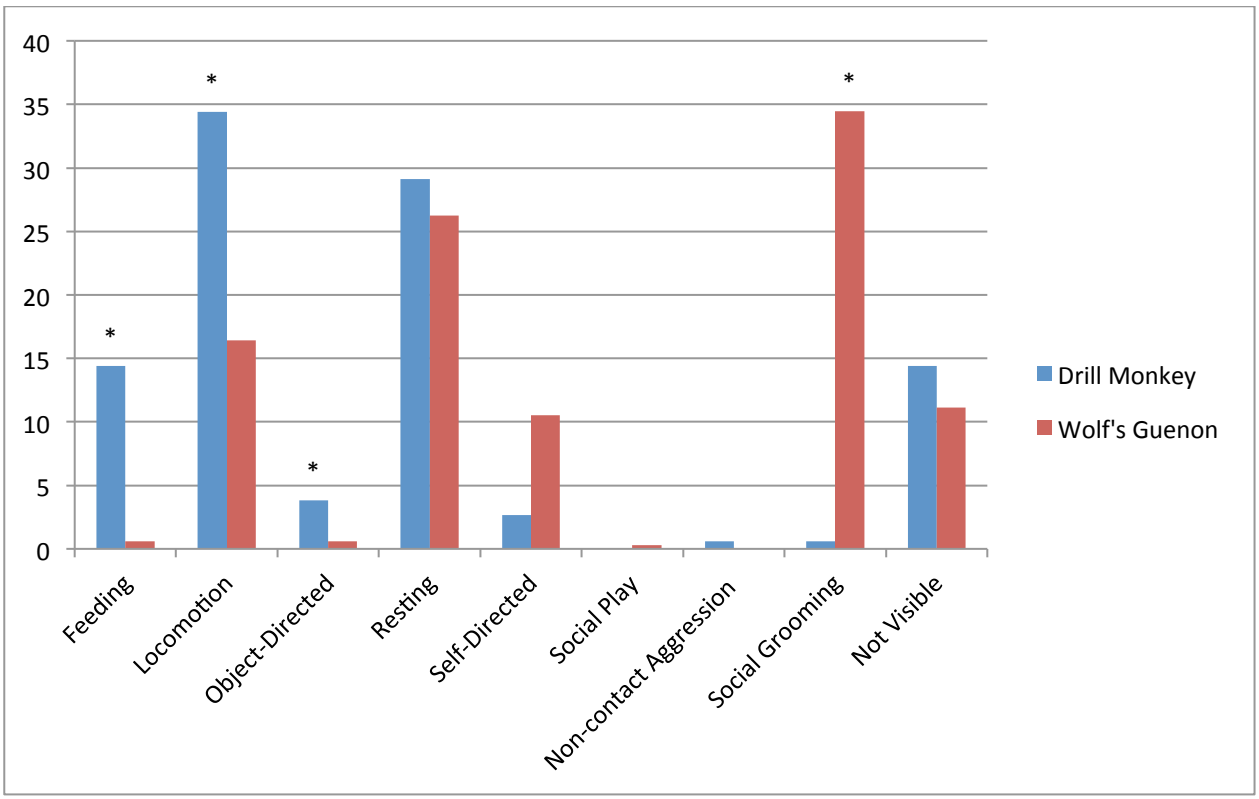

Figure 2. Overall Percentage of Behavior: Comparison of animal behavior in *C. wolfi* and *M. leucophaeus*; *Denotes significant difference in behavior.

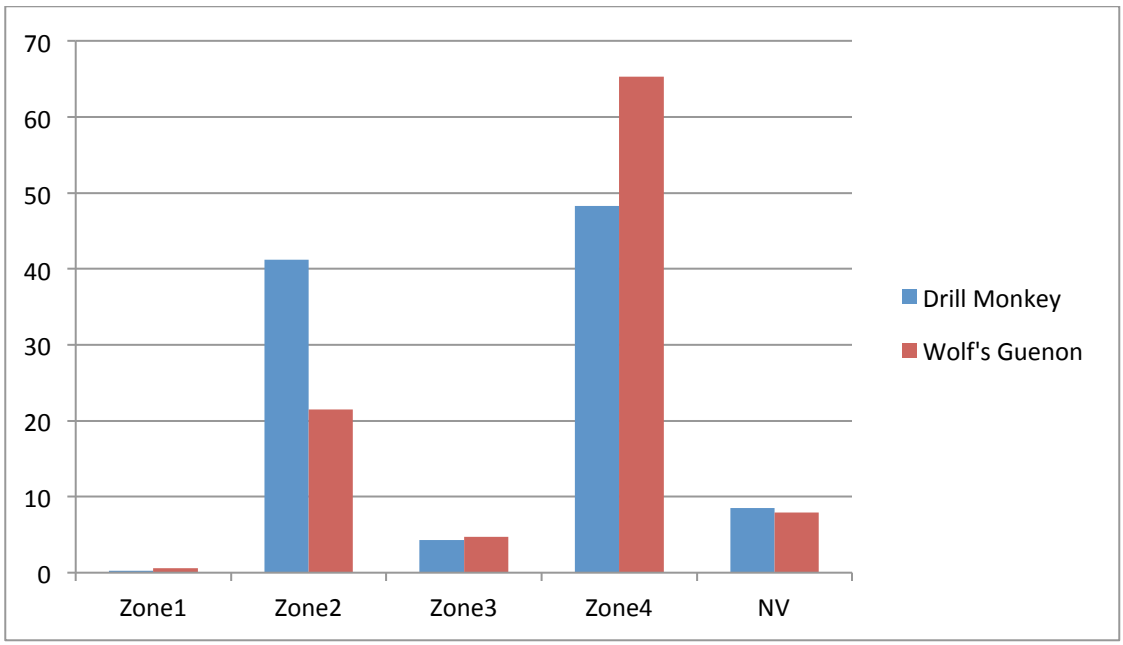

Figure 3. Overall Percentage of Zone Preference: Comparison of zone preference in *C. wolfi* and *M. leucophaeus;* No significant preference observed; both primates also spent about the same amount of time in NV (no visibility).

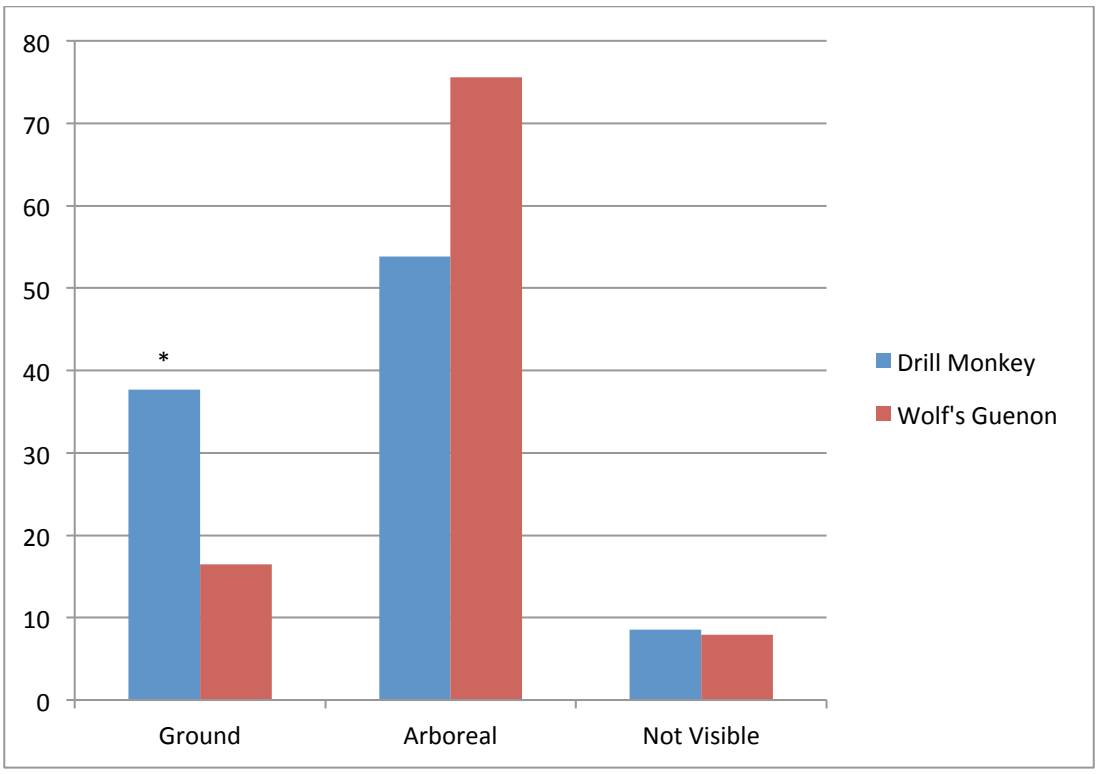

Figure 4. Overall Percentage of Ground and Arboreal preference: * Denotes significant preference of ground for *M. leucophaeus* while it appears that *C. wolfi* may prefer arboreal regions; both primates spent about same amount of time not visible.

Table 1: *Behavior Data Sheet*

Date _____ Cloud 0% 25% 50% 75% 100%
Time _____ Food Present _____ Observer _____
Temp _____ Humidity _____ Influence _____

In**stantaneous:**

30-sec	O	FD	LC	OD	RS	SD	SLP	CAS	CAD	NCAS	NCAI	SG	SCPS	SCPD
1	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
2	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
3	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
4	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
5	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
6	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
7	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
8	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
9	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:
10	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:	W: D:

Table 2: *Distance Data Sheet*

30s	# Zone 1	# Zone 2	# Zone 3	# Zone 4	Ground	Arboreal
1	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
2	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
3	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
4	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
5	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
6	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
7	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
8	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
9	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:
10	D: W:	D: W:	D: W:	D: W:	D: W:	D: W:

Appendix

MONKEY ETHOGRAM

Distance: Zone Diagram

Species: W – Wolf's Guenon, D – Drill Monkey

Behaviors

*Other– O

Animal is engaging in a behavior other than those described in this ethogram

*Feed – FD

Animal is gathering, processing, or consuming food, or drinking water

*Locomotion – LC

Animal is moving from point A to point B without doing anything else; includes climbing.

*Object Directed – OD

Animal manipulates any object other than food with mouth/hands/legs. Does not include object-directed play.

*Rest – RS

Animal is not moving and appears to be resting or sleeping. This can be in any location (on the ground, elevated, in water, etc.)

*Self-directed behavior – SD

Any behavior directed at self (grooming, scratching, picking teeth, etc).

*Solitary play – SLP

A sequence of behaviors that may include climbing, swinging, jumping or bouncing.

*Contact Aggression – CAS: Between same species

One animal forcefully places hands on another and pushes, punches, grabs, pulls, or bites at the other.

*Contact Aggression – CAD: Between different species

*Non-Contact Aggression – NCAS: Between same species

An animal lunges or rushes a couple of paces toward another but stops short of reaching the other, or one animal pursues another at a run.

*Non-Contact Aggression – NCAD: Between different species

*Social Groom – SG

One animal brushes through the fur of another with its hands, fingers, lips, and/or teeth.

*Social Play – SCPS: Between same species

One animal initiates play with another. A play sequence may include many behaviors otherwise seen in aggressive or affiliated situations (i.e. chasing, frolicking, leaping or wrestling) but in a disjointed order.

*Social Play – SCPD: Between different species