# Comparison of Self-Directed & Social Behaviors amongst a Captive Group of Mandrills (*Mandrillus sphinx*)

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# Comparison of Self-Directed & Social Behaviors amongst a Captive Group of Mandrills (*Mandrillus sphinx*)

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**ABSTRACT**

Mandrills (*Mandrillus sphinx*) are social and group-oriented primates. Like many primates, mandrills utilize self-directed behavior, but the function of these behaviors in this species is poorly known. In this project, the mandrills of the Cleveland Metroparks Zoo were observed to better understand the role of these behaviors. The four individuals on exhibit –Linus (α ♂), Woody (♂), Eebi (α ♀), and Zenani (♀)—were compared to refine comprehension of the social hierarchies amongst a given captive group. Hypotheses formed were: (1) males will exhibit more self-directed behaviors than the females; (2) individuals with higher social rank will exhibit less self-directed behaviors; and (3) there will be a higher rate of self-directed behavior post-conflict. Results found that none of these hypotheses could be supported either due to small population size or misconceptions on complex social animal behaviors.

*Key words*: Mandrills (*Mandrillus sphinx*); self-directed behavior; social behavior; gender; social hierarchy;

MANDRILLS (*MANDRILLUS SPHINX)* are a social and dynamic primate species (Honess & Marin 2006). Yet, there is very limited information on their behavior. Recent research has found that their life history is unique to other primates. They are group-oriented and have been documented to live in hordes of up to 900 individuals (Abernethy et al. 2002). They do not split up into separate groups and stay together as a unit whenever possible (Hongo 2014). They live exclusively in central western Africa in tropical rainforests within harems which consists of few males and many females. The amount of males depends on female abundance. Males contributed to about 4% of a given wild horde of 620 individuals (Abernethy et al. 2002). The males will only come in to mate with the females during their mating season (June-October) otherwise they emigrate from the horde. There is also the largest sexual dimorphism in this species of all the primates. These behaviors would suggest that the male does not provide any parental care to the offspring (Setchell et al. 2005). In fact, this horde is best characterized as a matrilineal lineage since all of the females live together as a family, acting as a team when taking care of offspring throughout their lifetime. This matrilineal lineage also determines social rank within the horde. The offspring will inherit their mother's social ranking (Setchell 1999).

With this complex social structure comes conflict and stress (Edwards et al. 2012). A male's facial coloration is directly correlated with fecal androgen levels as well as behavior (Setchell et al. 2008). This coloration may change due to different stress levels. Living within such a large horde with intense intraspecific competition is energy expensive yet necessary for reproductive success (Abernethy et al. 2002). This

indicates that mandrills are subjected to constant dominance aggression and most likely stress.

Self-directed behavior (SDB) is a common phenomenon observed in multiple primates such as barbary macaques, long-tailed macaques, and olive baboons (Edwards et al. 2012; Castles et al. 1998; Das et al. 1998). This is defined by a gesture or manipulation of the individual's body that they inflict upon themselves (Wagner et al. 2016). It seems out of the ordinary in the context of its surroundings and may be deemed random, but in most cases, it is not (Tinbergen 1952; Maestripieri et al. 1992). Common self-directed behaviors for primates include: yawning, scratching, and body shaking (Maestripieri et al. 1992; Castles et al. 1999). These behaviors are known to correlate with stress and anxiety levels due to the activation of the autonomic nervous system including changes in the respiratory and circulatory systems (Maestripieri et al. 1992; Troisi 2002). This results in physiological changes such as increased heart rate, blood pressure and plasma levels of corticosteroids. Also, when given anxiety medication such as anxiogenic or anxiolytic drugs individuals' SDB rates decrease (Maestripieri et al. 1992). SDB is found both in males and females, but the frequency may differ amongst genders.

Social behaviors were also taken into consideration since a cause of stress may be their conspecific. According to previous research, certain social behaviors are considered to indicate stress (Setchell et al. 2008), but due to the complexity of social bonds and interactions between animals it is not clear how this relates to all species. Social hierarchy is a key factor that affects stress which could influence the expression of a self-directed behavior (Abernethy et al. 2002). With higher social rank there could be more or less stress put upon an individual. Stress or cortisol levels can also be related to social hierarchy. There have been studies where the dominant male is subject to higher stress levels while others have suggested the opposite (Setchell et al. 2008). This relationship varies across species and is determined by multiple complicated factors such as mating systems, dominance hierarchies, and environment (Maestripieri et al. 1992; Setchell et al. 2008). Within the mandrills, it is predicted that the higher rank of an individual within a group, the lower levels of cortisol they will have.

Since conspecifics may be a cause of stress, SDB was observed post-conflict. Initiators and receivers are just as likely to display a SDB post-conflict suggesting this is stressful for both individuals (Castles et al. 1998). More conflict would likely result in an increase of self-directed behaviors. This is true within long-tailed macaques, but has not been studied within mandrills yet (Das et al. 1998).

Previous studies of mandrills are narrow and focus on their mating systems, group structures, physiological traits, and dominance hierarchies. Recent studies have gradually found more accurate information on this species' life history. Despite this, there is still limited research on social or stress behaviors within this species. This may be due to their concealed environment underneath thick forest canopies making it difficult to study them. Behavior is also a complex field of study that differs for every species. Broadening the knowledge of mandrill behavior would lead to more information on many other primate species as well.

In this study, exhibit observation will allow the investigator to identify underlying causes of any self-directed or social behavior. This may represent how their daily lives can affect stress levels. Social hierarchy will be observed since all of the group members can be compared at one

time. Males and females are not housed together due to aggressive interactions. When with the males, these specific females do not get along with each other. In gender separated exhibits the individuals coexist with less aggression. This tension amongst the genders in captivity may have not been present in natural conditions. Since these individuals' life histories are so different from their conspecifics in the wild this may explain why their behaviors may be expressed or function differently.

Despite the separation, they are still in close enough proximity to interact indirectly. Individuals are susceptible to the smell, sound, or sight of their conspecifics. A door with a small opening between the exhibits allows the subjects to occasionally see the opposite sex. This also allows for dispersal of sounds and smells amongst the mandrills' exhibits. These exposures may or may not alter behavior.

Knowing what causes these behaviors can enhance the quality of life for these animals. There is little known about mandrills, thus furthering research within this field is necessary for their welfare both in captivity and the wild. Validating if self-directed and certain social behaviors are correlated with stress can determine if they are having a negative impact on the individuals. Gaining more knowledge of one primate species can also show links to other primates including humans.

The ultimate goal is to relate *Homo sapiens* with other primates so that there is a heightened appreciation for them. Most humans do not realize the connection of all primate species. Some do not even realize that we are of the same phylogenetic family, Hominidae. Within Hominidae are four genera: *Pongo* (orangutans), *Gorilla*, *Pan* (chimpanzees), and *Homo* (humans) (Myers n.d.). Education may be an effective way to make these connections.

Humans and nonhuman primates share multiple similarities including genetics and behavior. Chimpanzees and humans are most closely related with 98.77% of the same DNA sequence (Chimpanzee Genome Consortium 2005). Brain development is also similar in that volume will triple during infancy for both genera (Matsuzawa 2007). Mother-infant relationships have also been compared within *Pan* and *Homo sapiens* individuals. The mother is the main parental care provider creating an intimate bond between them. The infant will cling to its mother for the first three months of its life. Afterwards, they are constantly together until the offspring reaches about four years old when it is mature enough to take care of itself (Matsuzawa 2001).

Chimpanzees also learn by observation and replication from elders homologous to humans. The best way to characterize this method of learning is "education by master apprenticeship" (Matsuzawa 2001). Infant chimpanzees' close bond to their mothers allows them to witness firsthand how she conducts daily tasks. The infant will learn mainly from its mother (Hirata & Celli 2003) as well as other older individuals of the community (Biro et al. 2003).

The plethora of information pertaining to chimpanzee life history, behavior, learning, etc. is probably due to the high similarities between them and humans. Additional mandrill research could allow for comparisons revealing any similarities. This appreciation would aid in conservation efforts for many endangered primate species. Mandrills have been considered vulnerable since 1986 due to hunting and habitat loss (Oates & Butynski 2008). These two issues are related since they are being hunted as a pest on plantations, but that would not happen as often if their habitat was not being destroyed. Learning more about primate

species preceding *Homo sapiens* can reveal information on human behavior as well.

Hypotheses formed were: (1) males will exhibit more self-directed behaviors than females; (2) individuals with higher social rank will exhibit less self-directed behaviors; and (3) there will be a higher rate of self-directed behavior post-conflict.

## METHODS

*SUBJECTS AND STUDY SITE*- The principal investigator observed the mandrills in their exhibit in the Primate, Cat, & Aquatics Building at the Cleveland Metroparks Zoo (CMZ), Cleveland, OH, USA (41.44654° N, -81.71185° E).

| Subject | Birth Date | Date of Arrival to CMZ |
|---|---|---|
| Linus (α M) | 10/05/08 | 3/28/13 |
| Woody (M) | 6/22/02 | 10/17/11 |
| Zenani (F) | 2/05/90 | 10/27/11 |
| Eebi (α F) | 3/30/97 | 10/27/11 |

Within the group, the dominant subjects were Linus and Eebi. The dominance hierarchy is clear within the males by Linus' facial coloration. The bright colors of red and blue on a male's face or bottom indicates his dominance among a horde (Wickings et al. 1993). The hierarchy within the captive females is less clear, but is determined by the amount of agonistic and dominance based behaviors demonstrated such as displacement. The more dominant individual will initiate the higher proportion of these behaviors. Thus, Eebi is dominant over Zenani (Figure 1). This is also true between the male subjects (Figure 2).

The temperature inside the building is regulated at about 24°C. Each exhibit measures approximately 8 x 5 x 5 meters. There are three exhibits for the mandrills, one for the females and either one or two connected rooms for the males. Their exhibits may fluctuate daily due to cleaning or weather. During colder days the gorillas may be moved inside to one of these exhibits, if needed.

*DATA COLLECTION*- All data were collected between 11am and 4pm on Saturdays and/or Sundays from September 24 to November 6, 2016. The investigator would observe all of the subjects simultaneously, if possible. The investigator's observation point would be determined based on the location of the subjects. Usually the observation point was about three meters from the windows of the exhibits. If guests obscured this view then the investigator would move to a point within zero to three meters of the window with the least obscured view. If all subjects were on exhibit the investigator's location would be wherever all were visible. If subjects were all on exhibit, but not all visible at one time, then the investigator would pace back and forth to increase viewing time of each subject. Periods where all subjects were not able to be viewed at one time were neither frequent nor long durations. There were limited places where a subject could not be seen at all allowing for nearly all behaviors to be recorded.

Shifts of up to five hours allowed for extended observing opportunities. This span of time throughout a few months can provide a range of seasons that may attribute to any behaviors. A total of 35 hours of data were collected. Each trial was thirty minutes with the following recorded: date, exhibit, trial start time, subject, behavior, time of behavior, location on body, site in exhibit based on zone and height, structure, and conspecific proximity.

An ethogram was used to define the more commonly predicted behaviors the mandrills were likely to express which may

include self-directed and social behavior (Table 1). Location on body where the self-directed behavior occurred was recorded to detect any possible patterns. The body was divided into three segments: head, thorax, and limbs. Previous studies have revealed that location on the body may correlate with positive or negative experiences (Wagner et al. 2016).

The site in exhibit was also recorded to measure where behaviors most commonly occurred as location may be a determining factor. There were distinct areas where each individual preferred to spend most of their time either due to feeding or sleeping. By identifying where they display more SDB this may reveal their "safe space" or where they like to spend time away from their conspecific. There may be more or less SDB in this personal space depending on individual preference. The exhibits were broken into zones and height (Figure 3).

Depth was also taken into consideration within the exhibit; front, mid, or back. Front was characterized as one meter within the window of exhibit. Height was also recorded as low, mid, or high. Low was characterized as touching the lowest surface within the enclosure (the ground). High was considered anything higher than one body length's reach of the individual. While mid was depicted as anything between these two heights or suspended in the air such as on a branch or the lower parts of the tree structure.

Conspecific proximity was noted to determine if more self-directed or social behaviors occurred while in closer or further proximity of the other. Distance was measured as body lengths from each other: 0 (or contact) 1, 2, 3, 4, 5, or 5+. There were multiple structures within each exhibit the mandrills could be located. Each structure was identified in the beginning of the study and is permanent throughout data collection. In exhibit one, the following structures were identified: ground, rock (mid/high), platform (left/right), tubes (left, mid, right) and branches (low/up). Exhibit two and three: ground, ropes, rock and tree (mid/high).

*DATA ANALYSIS*- Data were analyzed using nonparametric t-tests to account for the smaller sample size of data collection. Although there were 35 hours of data, this is still a small amount of time to see complex social behaviors. The third hypothesis (there will be a higher rate of self-directed behavior post-conflict) was conducted by identifying an aggressive behavior (displacement, contact aggression and non-contact aggression) and then counting how many self-directed behaviors occurred within five minutes after the conflict. This was compared to a matched control. This was determined by using the conflict aggression identified, but on a different day where no aggression occurred at the same time. Self-directed behavior was also counted after this no conflict period.

## RESULTS

Proportion of time spent performing a self-directed behavior was compared between the males and females (Figure 4). Males did spend more time than females scratching, yawning, and body shaking, but the difference between the two was not significant ($p=0.56$). Dominant individuals were also compared to subordinate individuals (Figures 5 & 6). When comparing the males, Linus actually spent more time than Woody engaging in self-directed behaviors, but not by a significant difference ($p=0.40$). In contrast, the dominant female, Eebi, showed less self-directed behaviors than her subordinate. This also yielded a non-significant value ($p=0.32$). Post-conflict and matched control periods were compared for each individual (Table 2). No significant effects were detected.

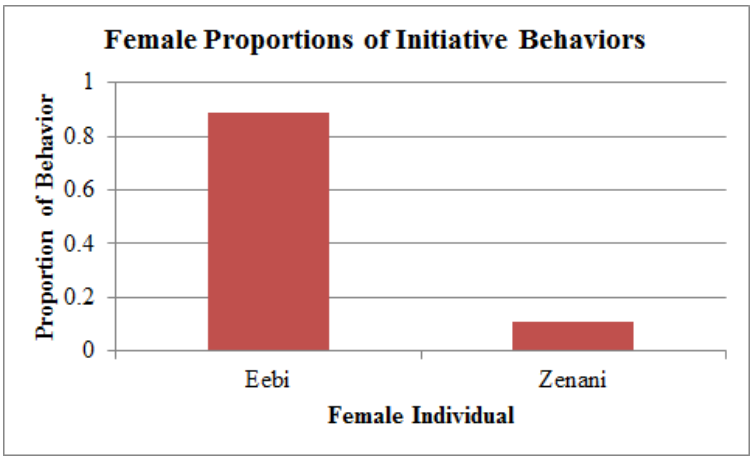


**Figure 1.** Female proportions of initiative social behavior determining the dominance hierarchy.

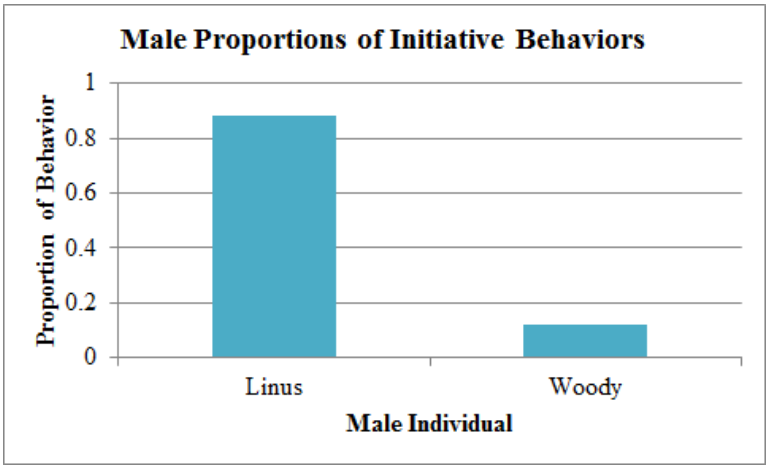


**Figure 2.** Male proportions of initiative social behavior determining the dominance hierarchy.

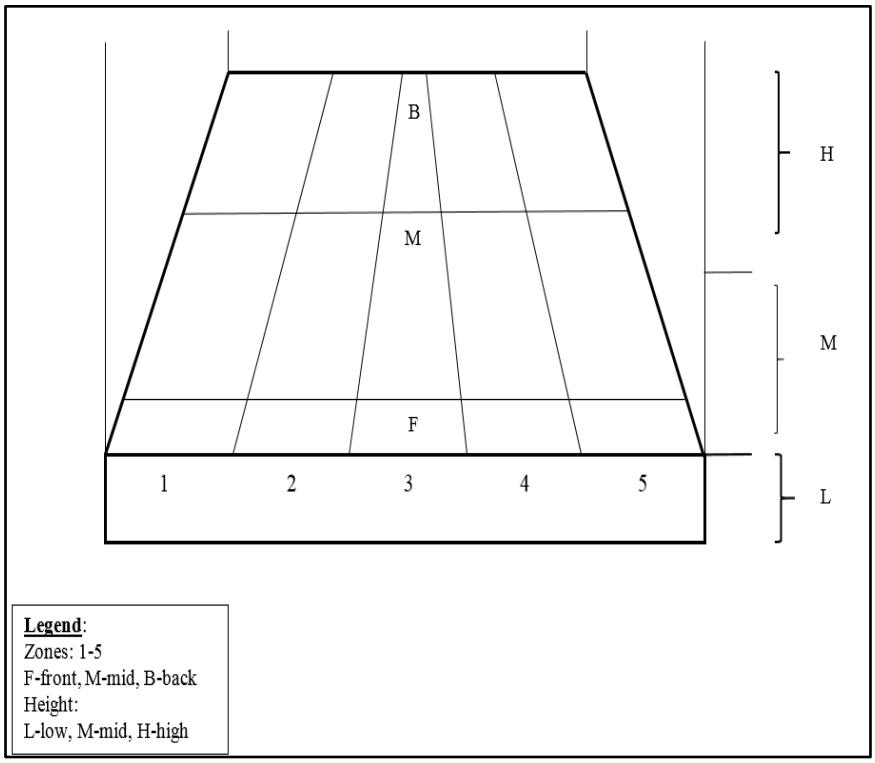


**Figure 3.** Diagram of exhibit broken down into zones and height.

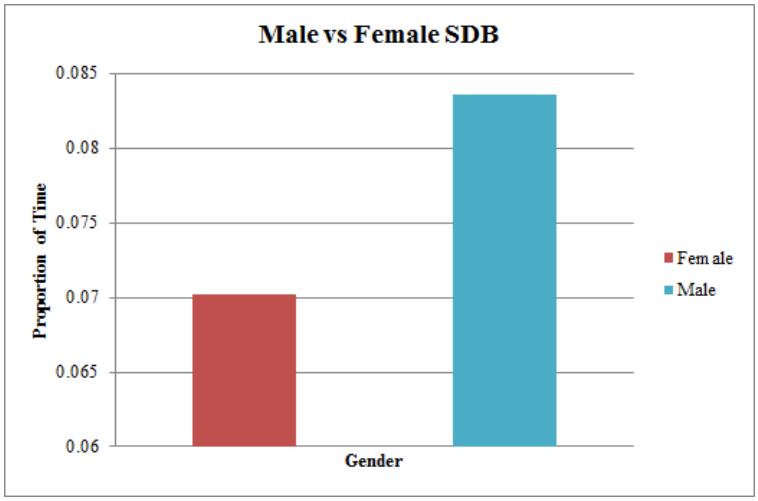


**Figure 4.** Male versus female proportion of time spent engaging in a self-directed behavior (p-value=0.56).

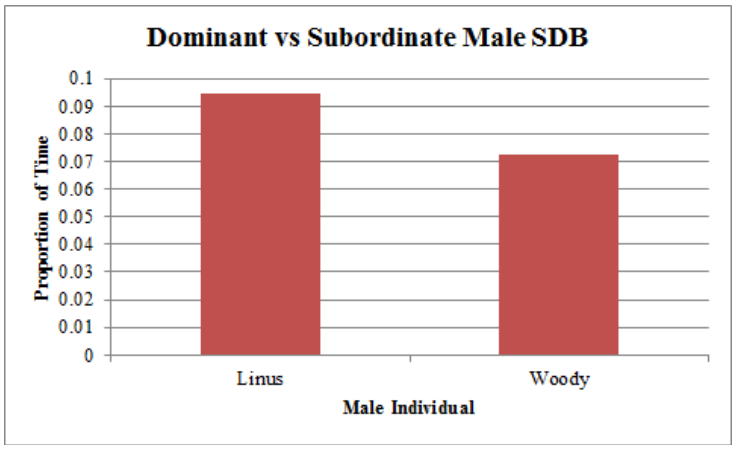


**Figure 5.** Dominant (Linus) versus subordinate (Woody) males' proportion of time spent engaging in a self-directed behavior (p=0.40).

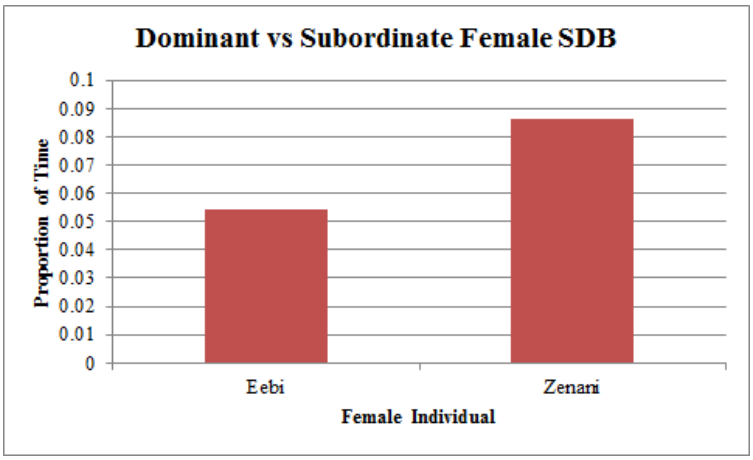


**Figure 6.** Dominant (Eebi) versus subordinate (Zenani) females' proportion of time spent engaging in a self-directed behavior (p=0.32).

**Table 1.** Ethogram of mandrill behaviors (Leeds 2016). Provided by Austin Leeds with some additional behaviors added by investigator.

| **Social & Self-Directed Behavior** | |
|---|---|
| ***Social Behavior*** | |
| *Dominance* | |
| Displacement | Subject approaches conspecific, resulting in the conspecific leaving and the subject taking his previous place or general vicinity. |
| Display | Subject charges, slaps ground, shakes enclosure item, etc. none of which are |

| | |
|---|---|
| | directed towards a conspecific. |
| General Displacement | Subject approaches conspecific, resulting in the conspecific leaving and the subject taking over their previous general vicinity, not specific spot. |
| *Submissive* | |
| Present | Subject turns hips and bottom to conspecific while looking over shoulder towards the receiver |
| *Agonistic* | |
| Contact Aggression | Subject aggresses towards a conspecific with direct physical contact. May include slapping, hitting, kicking, biting, hair pulling and may be accompanied by screams. |
| Non-Contact Aggression | Subject aggresses towards a conspecific with no physical contact. May include chasing, ground slapping, eye flashing, crest raise, and forward lunging. |
| *Affiliative* | |
| Play | Subject engages non-aggressively with conspecific. Includes play behaviors such as play slapping, grabbing, and biting. Subjects may press faces together while engaged in physical contact. Also includes brief touches of a conspecific's face or rear end used to initiate play. |
| Silent Bared-Teeth Face | Subject curls lips back in a horizontal figure eight shape, revealing the canines and premolars. The sagittal crest is the erected and the head is shaken from side to side (Laidre & Yorzinski, 2005). |
| Crest Raise | Subject erects the sagittal crest. Not coded when accompanied with silent bared-teeth face. |
| Greeting | Subject will stand up on hind legs against the door between exhibit 1 & 2. May include sniffing or putting ear against wall to see what is on the other side. |
| Hand stand | Subject will bend over and touch the ground with his hands while sticking his head under his legs. |
| ***Self-Directed Behavior*** | |
| Self-Scratch | Subject rakes fingers across body in a fast manner. |
| Yawn | Opens mouth to expel air while exposing teeth. |
| Body Shake | The individual becomes pilo-erect and twist body back and forth quickly. |

**Table 2.** Each individual's post-conflict self-directed behavior rate and corresponding p-value.

| Post-Conflict SDB Rate | |
|---|---|
| **Subject** | **P-value** |
| Linus | 0.525 |
| Woody | 1 |
| Eebi | 0.704 |
| Zenani | 0.431 |

## DISCUSSION

Results indicated that all hypotheses could not be supported. Hypothesis (1), males will exhibit more self-directed behaviors than the females, did not have enough data to support this statement. Males did spend more of their time engaging in self-directed behaviors, but there was not enough of a difference between the two (Figure 4). Despite the males' proportions being higher, when each self-directed behavior was examined individually there still was no significant difference between the genders.

Results for hypothesis (2), individuals with higher social rank will exhibit less self-directed behaviors, was also not supported. Linus had a higher proportion of behavior compared to Woody, but the difference was not significant. On the other hand, Eebi, the dominant female, had a lower proportion than her subordinate, Zenani. This may indicate that social stress within a hierarchy may not elicit self-directed behaviors. This could differ across species causing the unexpected results, but a more likely reason would be the unnatural conditions. These zoo animals were born in captivity which led them to live in a much smaller group of four instead of hundreds.

The final hypothesis, (3) there will be a higher rate of social behavior post-conflict, was not supported by data either. Each individual's self-directed behavior was compared after conflict and during control periods, and no significant differences were detected. It seemed that self-directed behavior occurred throughout the sampling period without conflict influencing the rate. During data collection, it seemed that there was more of an effect when there was a disturbance around the exhibit from outside sources such as feeding time or guests interacting with the subjects. A zookeeper is associated with feeding time which would naturally give the individual a reason to be enthusiastic. Guests tend to tap on the glass or walk alongside the mandrills as they walk across the front of the exhibit. Many times this resulted in the subject reacting to the guests' actions by a self-directed behavior, slapping the glass, or lunging towards the guests as if to intimidate them.

It is possible that significant effects would have been detected with a larger sample size and/or longer data collection durations. Four individuals within a group are not considered natural conditions for this species. With genders separated the sample size becomes very small which is not ideal for statistical analysis. Despite the substantial amount of behaviors recorded, the intervals of collections only account for

about 13% of the mandrill's day. This is not very representative and longer data collection could help with this issue.

If these behaviors indicate stress future studies could be conducted to limit them. The mandrills of the CMZ are not in any way unhealthy or malnourished, but conditions can always be improved to ameliorate social or mental health. Cortisol or stress levels are directly associated with health (Shivley & Day 2015). The higher the stress with longer durations, the unhealthier an individual will be. Cortisol levels have been known to directly correlate with lowered immune systems (Sapolsky 1995). This is true within almost all species, even humans. Stress has been known to cause numerous diseases such as post-traumatic stress disorder, schizophrenia, and depression (Chetty et al. 2014). Some things that could contribute to elevate welfare are less negative guest-animal interactions as well as building intraspecific relationships.

Most guest-animal interactions were antagonistic. The guests like to get the animal's attention by pounding on the glass or getting as close to the mandrill as they can which often lead to slapping/lunging towards the glass and/or self-directed behaviors. One instance, a laser pointer was even shined into Eebi's eye. Reducing these negative interactions may lessen the amount of self-directed behavior as well as enhance the animal's experience.

It seemed that the dominant individual threatened the other which directly impacted their behavior. The receiver would make decisions based on the dominant's location. For instance, Zenani would be calmly sitting in the upper parts of the exhibit, but once Eebi approached within a certain distance from her she would get up abruptly and avoid Eebi. This was labelled as "usual displacement" between these two individuals due to its frequent occurrence during data collection. Since these two are family and have lived with each other for almost two decades, this will have an effect on their relationship. They are used to each other's behaviors and habits which seems to increase conflict. Building intrasexual and/or intraspecific relationships could include therapeutic activities that would allow the individuals to associate positive experiences or objects with their conspecific. This could aid in the tension between Eebi and Zenani. If this were successful, it could also improve intraspecific relationships which could allow the group to live together without negative social interactions. Additional research would be needed to fully comprehend the social dynamics of this species so that this strategy could be most effective.

Behavior is a very complex phenomenon within every organism. It is different within every species and for each individual. It depends on genetics as well as environment. Within all of the different climates of the world there are also a multitude of niches that make every habitat unique. Thus, social behavior is a difficult field of study leading to multiple interpretations of behavior. With limited research, especially for mandrills, it is hard to distinguish facts. Furthering the research within mandrill behavior can hopefully reveal more valuable information about these primates. With the lack of supporting data, this study may have revealed that scratching, yawning, and body shaking may not indicate stress in this species as previously believed. Captive species may have diverged into a new subpopulation due to extensive differences in life history. This study could have revealed captive versus wild mandrill social behavior differences.

Stress behaviors can also vary from each individual based on their past experiences or preferences. For instance, Woody exclusively displayed a few other behaviors that were not already identified.

One of which was the "hand stand". He would bend his upper abdomen toward the ground while keeping his feet flat. He then would touch the ground with his hands and look through his legs behind him. This behavior always occurred at the front of the exhibit next to the window on the left side. It occurred in both of the exhibits the males were exposed to, but always in the same location of any exhibit. When he did engage in this behavior it would happen more than one time within a five minute period. He would pace from the right side of the exhibit to the left corner, perform his "hand stand", and start walking back to the right corner. This pacing would happen a few times in a row with a hand stand always occurring at the left corner. There was no conflict within five minutes preceding his hand stands though. Therefore, the stimulus may not be his conspecific.

Since no other subjects performed this behavior this exemplifies the personal preference within each individual. This behavior may indicate stress which would support the idea that individuals prefer specific stress behaviors. If this behavior does not indicate stress it may be due to other factors such as entertainment. Woody may be bored and will engage in this behavior to entertain the guests which could also entertain himself. This may be the case if an increase in his enrichment reduces this "hand stand" behavior.

Another future study that would be beneficial to behavioral science is correlating these behaviors with regions of the brain. Directly linking brain activity after a behavior would reveal the function and reason behind it and also maybe what the stimulus could have been.


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