Comparison of Agonistic Behaviors by analysis of activity in two groups of Confined Primates, Mandrills (Mandrillus sphinx) and Ring-tailed Lemurs (Lemur catta)

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Comparison of Agonistic Behaviors by analysis of activity in two groups of Confined Primates, Mandrills (*Mandrillus sphinx*) and Ring-tailed Lemurs (*Lemur catta*)

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Undergraduate Thesis for the Honors Program

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Abstract

Behavior in a confined group of mandrills (Mandrillus sphinx) and a confined group of ring tailed lemurs (Lemur catta) were analyzed to reveal any significant differences in agonistic behaviors and to assess the varying stress levels between individuals. I predicted that the activity rate of the individuals would determine the amount of agonistic behavior demonstrated, specifically that more active individuals would be more frequently performing agonistic behaviors than those who were less active. The mandrills as a whole exhibited a higher activity rate than the lemurs, and the proportion of time spent exhibiting agonistic behaviors was also higher, as expected. These results suggest that the mandrill population is under more stress than the lemurs. Differences in the age makeup of these groups may partially explain the behavioral differences that occurred: the mandrills’ group included a juvenile who was considerably more active than his parents while all three lemurs observed were adults. Differences in the size of the exhibit may also explain the differences as the exhibit for the mandrills was smaller than that of the lemurs, while the mandrills were more than triple the lemurs’ size. This analysis supports earlier studies: that primate behavior is influenced strongly by their environment and its cohabitants.
Introduction

The mandrill (*Mandrillus sphinx*) and the ring-tailed lemur (*Lemur catta*) are both primates, the former being an Old World Monkey of the subfamily Cercopithecinae and the latter a prosimian in the family Lemuridae. The mandrill is found in the rain forests of Gabon while the ring-tailed lemur is native to the dry forests of Madagascar. Studies of wild mandrills are particularly difficult to conduct [Jouventin, 1975; Napier and Napier, 1967], because of their large troop size and the dense forest, while several successful studies of wild ring-tailed lemurs have been conducted, including those of Allison Jolly [1966]. In either case, studies of captive animals are useful in understanding behavioral patterns and additionally, in lemurs, can be compared to those in the wild.

Both species used in this study naturally form large groups in the wild. Wild ring-tailed lemurs live in groups of approximately seven to twenty individuals while wild mandrills live in groups as large as fourteen to six hundred individuals. It is difficult for zoological parks to preserve these group structures due to the limitations of space, money, and employees as well as the compatibility of individual animals. At the same time, it is essential for these animals to be brought up near other individuals so that appropriate behaviors can be learned. Separation from other individuals can also result in stereotypic behavior like rocking back and forth or any other repetitive, atypical movement [Harlow and Harlow, 1962; Fobes and King, 1982]. This fact can frustrate any program intended to preserve an endangered or threatened species or any researcher who is observing wild animals in a captive environment. Therefore, it was decided that the populations observed must consist of more than one individual.
It is a goal of Zoo New England to promote the genetic diversity of these animals as well as to replicate natural environments as closely as possible. There were breeding programs in effect in both of the lemurs and mandrills while observations were made. Midway through observations, the size of the lemur troop was increased by one adult female who was intended to form a breeding pair with the adult male, with whom she had previously been bred. That pregnancy resulted in a still birth. She had been in holding for approximately one year recovering from surgery on a torn ACL.

The purpose of this study was to identify and observe the agonistic behaviors of two different populations of primates and to compare them to the rate of activity exhibited in order to assess varying stress levels between individuals. Agonistic behavior is a display of aggressive or threat behavior, usually against another individual [Whiteman & Côté, 2004]. In primates, these behaviors include threat yawns, a yawn exposing all of the teeth to exhibit the potential threat that the individual proposes, as well as displacement behavior, in which the more dominant animal will walk over to the place a subordinate is located, causing the subordinate to flee, and then occupying that position [Fobes, 1982]. More species-specific agonistic behavior in mandrills includes bobbing of the head, slapping the ground with a hand, and raising the hair on the back of the neck [Wood, personal communication]. In lemurs, the species-specific agonistic behavior includes cuffing, feinting at another individual, and spats, which are brief aggressive encounters in which a certain call is given. Scent-marking, in which both males and females use their genitals to mark branches is too generalized an attribute to truly be considered agonistic. Another threat behavior includes stink-fighting in which the male lemur will sit on his hind legs with his tail between his legs, use his brachial and
antebrachial scent glands to mark his tail, and then stand on all fours, bobbing his tail rapidly [Jolly 1966].

Agonistic behavior is thought to be provoked by stress [Keenan et al. 2003; Wommack et al., 2003], which can play an important role in health as prolonged exposure to stress increases the number of glucocorticoids released from the adrenal glands [Campbell et al., 2000; Leutwyler, 1998]. These glucocorticoids suppress the immune system, making the individual more susceptible to illness by infectious agents. Therefore, it is valuable to study the incidence of agonistic behavior to determine the amount of stress that animals experience in zoological exhibits.

Research has revealed that the size of the captive environment will have an affect on some social behaviors [Chang et al., 1999]. The mandrills’ exhibit is approximately two-thirds the size of the lemurs, while the lemurs themselves are markedly smaller than mandrills. The average body weight for lemurs is approximately three kilograms for both males and females. The average weight for a male mandrill is twenty seven kilograms and the female mandrill is eleven kilograms. The mandrills on exhibit consisted of three individuals, one adult male, one adult female, and their juvenile son. For the first part of the research project, one adult male lemur and one adult female lemur were on display. After January 29th, the second female was added and the population consisted of two adult females and one male.

Additionally, it was hypothesized that the activity rate of individuals in an environment makes them more or less likely to interact with others. A more active individual is more likely to interact with others than one that is less active [Terdal,
This activity can be due to the age composition of the group. For example, it is likely that a population of individuals in which there is a juvenile will also be more active, due to the nature of the juvenile as well as the other’s response to him. Therefore, it was proposed that the activity of each group will directly relate to its incidence of agonistic behavior. The data gathered should show that the less active population should experience fewer agonistic behaviors and therefore less amount of stress. Other factors that might influence stress, such as the method of feeding, amount and availability of food, will be controlled by the employees of the zoo.

Method

Subjects

Throughout the study, the subjects comprised at least two lemurs, an adult female (“Emily,” 7 years old) and an adult male (“Shorty,” 10 years old) [Fig.s 1a and 1b] and 3 mandrills, an adult male (“Charlie,” 13 years old), and adult female (“Mandy,” 16 years
Figure 2a and 2b. 2a. Charlie, the adult male mandrill. 2b. Mandy and Woody, the adult female and male juvenile mandrill.

old) and their juvenile male offspring (“Woody”, 1.5 years old) [Fig. 2a and 2b].

Halfway through the investigation, a second adult female was added to the lemur exhibit (“LuLu,” age uncertain) [Fig. 1a]. All animals were captive born with the exception of the female lemur “Emily” that was a former pet.

Procedure

The first author conducted all behavioral observations. The animals were observed from October to December 2003 and from January 29th to March 11th after they were released from the holding area into their exhibits in the morning. The animals were placed in holding every evening upon the closing of the zoo and were not released the next morning until their exhibits had been cleaned and new food placed on exhibit. Each
species was observed for at least an hour and a half during each observation session. The first animal observed would be rotated each observation period to maintain balanced observations. Chang [1999] used a protocol for behavioral studies of mandrill (*Mandrillus sphinx*) adapted from the behavioral studies of Cox and Hearn [1989] in an unpublished ethogram. This protocol was adapted for use in this study. Behaviors were recorded according to a hierarchical list of categories (Table 1). In other words, the behaviors were listed in an order that illustrates the relative importance of each behavior. For example, the social behaviors have more significance than the solitary behaviors, and all of the behaviors are more significant than being not visible.

<table>
<thead>
<tr>
<th>Social</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Groom/Be Groomed</td>
<td>Animal picks through the fur of another animal or another animal grooms the animal with fingers or mouth.</td>
</tr>
<tr>
<td>Play</td>
<td>Animal engages in running, chasing, tumbling, pulling, pushing, or grappling with one or more other animals.</td>
</tr>
<tr>
<td>Agonistic</td>
<td>Animal engages in aggressive, dominant, or threat behavior towards other. Includes threat yawn and displacement behavior.</td>
</tr>
<tr>
<td>Other social activity</td>
<td>Animal engages in any social behavior not including above (including vocalization and scent marking.)</td>
</tr>
<tr>
<td>Solitary</td>
<td></td>
</tr>
<tr>
<td>Feed</td>
<td>Animal engages in an activity directly related to acquisition and intake of food or fluid (including forage, stalk, eat, chew, and drink.)</td>
</tr>
<tr>
<td>Explore</td>
<td>Animal looks intently at an object in close proximity or manipulates object or area with hands, feet, or mouth (without consumption)</td>
</tr>
<tr>
<td>Move</td>
<td>Animal moves from one place to another (includes walking, crawling, scooting, running, climbing, swinging, and jumping).</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Animal engages in an activity that contributes to physiological well-being (includes self-groom, self-inspect, scratch, cough, sneeze, eye-wipe, urinate, defecate, and comfort movements).</td>
</tr>
<tr>
<td>Stationary</td>
<td>Animal is not moving (includes sleep, lie, sit, and stand). Animal may or may not be alert.</td>
</tr>
<tr>
<td>Not visible</td>
<td>Animal is not visible to observer.</td>
</tr>
</tbody>
</table>

**Table 1. Hierarchical list of behavior categories**
Data Collection

Each observation period was divided into fifteen minute focal periods. In each focal period, only one animal was observed, with all time spent recorded in one of the behavior categories listed above. The order in which the animals were observed was rotated to eliminate any bias. From these, percent of time spent in each activity was derived by calculating the mean number of seconds per 900 second (15 minute) period spent by each animal in each activity.

Analysis

The active behaviors will be summed for each period and then averaged to determine the mean number of seconds spent in activity. Charts were constructed using this number as a percentage of the total time (i.e., out of nine hundred seconds) as well as dividing the mean number of seconds in agonistic behaviors by the mean number of seconds spent in activity. Significant differences were determined by a unpaired t-test, and a correlation between activity and agonism will be determined using Pearson’s coefficient.

Results

Baseline

All results are summarized in Table 2 below.

Fourteen 900 second samples of data were collected for Shorty and Emily, while four fifteen minute samples of data were collected for Lulu. All the lemurs spent the majority of their time either still or not visible. Emily spent 62% of her time still and 25% not visible while Shorty spent 60% of his time still and 17% not visible. Lulu spent 46% of her time still and 40% of her time not visible. Little time was spent in the rest of
Figure 3. Mean number of seconds in a nine hundred second interval spent in behaviors by the ring-tailed lemurs.
Figure 4. The mean number of seconds in a one hundred second interval the mandrills spent in each behavior.
Figure 5. The mean percent of time spent by each animal in all active behaviors.
Figure 6. The mean number of seconds spent in agonistic behavior divided by the mean number of seconds spent in active behaviors for all observed animals.
the behaviors. Shorty spent no time exhibiting agonistic behavior, while Emily spent 0.2% of her time, and Lulu 0.1% of her time (Fig. 3).

Eleven 900 second samples of data were collected for each mandrill. Charlie differed from the other mandrills by spending 46% of his time still, with the Mandy and Woody spending 14% and 1% respectively of their time still. Woody spent 49% of his time exploring, while Mandy and Charlie spent 0.2 and 0% respectively of their time in this activity. Both Mandy and Charlie spent a large amount of time feeding, 47% and 40% respectively. Charlie and Woody spent approximately the same amount of time being groomed (0.4% and 0.6% respectively) while Mandy spent 10% of her time in that behavior. Little time was spent playing, in other social behaviors, moving, in maintenance activities, and not visible for all three mandrills. The mandrills spent approximately the same amount of time exhibiting agonistic behavior. Both Mandy and Woody spent 2% of their time exhibiting this behavior while Charlie spent 1% of his time in this behavior.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Emily</th>
<th>Shorty</th>
<th>Lulu</th>
<th>Charlie</th>
<th>Mandy</th>
<th>Woody</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groom/Being Groomed</td>
<td>2</td>
<td>4.5</td>
<td>1</td>
<td>0.4</td>
<td>10</td>
<td>0.6</td>
</tr>
<tr>
<td>Play</td>
<td>0.3</td>
<td>0.8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Agonistic</td>
<td>0.2</td>
<td>0</td>
<td>0.1</td>
<td>0.4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other social</td>
<td>0.3</td>
<td>2.5</td>
<td>0.4</td>
<td>0.4</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Feed</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>40</td>
<td>47</td>
<td>13</td>
</tr>
<tr>
<td>Explore</td>
<td>0.5</td>
<td>0.2</td>
<td>0</td>
<td>0</td>
<td>0.2</td>
<td>49</td>
</tr>
<tr>
<td>Move</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>0.4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Maintenance</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Stationary</td>
<td>62</td>
<td>60</td>
<td>46</td>
<td>46</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Not visible</td>
<td>25</td>
<td>17</td>
<td>43</td>
<td>6</td>
<td>21</td>
<td>19</td>
</tr>
</tbody>
</table>

Table 2. Mean percent of time spent by each animal in each behavior.
An analysis of activity was also performed by averaging the amount of time spent in active behaviors (i.e. all behaviors besides still and not visible) and dividing that by the amount of time observed. It was found that Emily was active on average 13% of the time. Shorty was active 24% of the time observed, and Lulu 11% of the time observed. Woody was active 79% of the time observed. Mandy was active 65% of the time observed, and Charlie was active 48% of the time observed (Fig. 5).

Finally, the percent of time exhibiting agonistic behavior divided by percent of time spent in active behaviors was determined. Emily spent 1 percent of her active time exhibiting agonistic behavior, Shorty 0 percent, and Lulu 1 percent of her active time. Charlie spent 2 percent of his active time exhibiting agonistic behavior, Mandy 3 percent, and Woody 3 percent (Fig. 6).

Statistical analysis was conducted using an unpaired, two-tailed t test (SPSS software). It was found that there was a significant difference in the amount of agonism between the two species of primates (p=0.005), with the mandrills being the more agonistic. There was also a significant difference between the amount of activity between the two species of primates, again with the mandrills being the more active of the two (p< 0.001). However, there appeared to be no correlation between activity and agonism (p= 0.072).

Discussion

My results are consistent with my expectations, specifically, that the more active species would also be the more agonistic species. It is interesting to note that there is no correlation between activity and agonism. However, that may be due simply to the fact that the lemurs exhibited so little agonistic behavior that the correlation was impossible.
The data collected for the mandrills were compared to several other studies performed in captive situations to assess its accuracy. The ethograms generated here resemble those constructed by Chang [1999], Mellen [1981], and Terdal [1997] (Table 2). These data suggest that the mandrills at the Franklin Park Zoo are acting in a manner that is typical of captive mandrills in the United States. As there is little data on mandrills in the field, it is difficult to ascertain if this captive behavior is also representative of wild mandrills. However, as the mandrills exhibited the full range of behaviors listed in the ethogram of Cox and Hearn [1989], they are most likely a reasonable representation of a wild population.

These results were also anticipated due to the fact that the mandrills’ exhibit included a typically active juvenile. His rambunctiousness was likely to irritate his parents. He frequently disturbed Charlie’s sleep with his activity, who would be provoked to giving several threatening head bobs, or a hand-slapping, head bob combination depending on the severity of his behavior. Also, Woody elicits agonistic behavior frequently from his mother by pretending to wrap a vine around his neck, upon which she slaps the ground furiously and raises all the hair on her head. Although

<table>
<thead>
<tr>
<th>Environment</th>
<th>Feeding</th>
<th>Moving</th>
<th>Stationary</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo Hanover and Zoo Tulsa (Terdal 1997)</td>
<td>21</td>
<td>8</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>Traditional (Sibley and Krauss, this study)</td>
<td>34</td>
<td>2</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>Traditional (Chang et al. 1999)</td>
<td>36</td>
<td>6</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Enriched traditional (Mellen et al. 1981)</td>
<td>52</td>
<td>_</td>
<td>_</td>
<td>20</td>
</tr>
<tr>
<td>Ecologically representative (Chang et al. 1999)</td>
<td>66</td>
<td>7</td>
<td>12</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 3. Comparison of select activities in captive environments.
Woody himself initially was not prone to any agonism, he was seen attacking and biting his mother towards the end of the observations. This occurred when Mandy was at the peak of her estrous cycle, and was therefore a constant focus of Charlie’s energy. However, Mandy was observed at the peak of her estrous cycle at least three times during the observation period, and was only subject to Woody’s aggressive behavior in that one instance. Although there was one instance observed in which agonistic behavior was directed toward a spectator, all of the agonistic behavior recorded was directed towards another resident in the exhibit. The one observed incident consisted of Charlie reacting to several adult male individuals standing very close to the exhibit while he was at the exhibit’s anterior; however, Charlie’s behaviors were not being recorded at the time.

Woody’s hyperactivity provoked the other individuals in the exhibit to act in non-aggressive ways as well. Frequently Mandy, his mother, would groom or allow her son to nurse if he was in need of comfort or apparently being very difficult to calm. These instances of affiliative behavior, or behavior that is appeasing and helps create a bond [Terdal, 1997] would frequently occur after a bout of pretend hanging. Woody usually avoided Charlie at all times, and only provoked him if he disturbed his sleep. Because of his activity, Woody most likely increased the incidence of agonistic behavior observed. This could be one of the reasons why captive mandrills exhibit more agonistic behavior than wild mandrills [Tilmans, 1997].

The amount of agonism observed in the mandrill population does not seem to be high, though there have not been any levels of agonism activity established as such. As research indicates that there is a correlation between stress and agonism [Keenan et al., 1997].
the exhibition of agonistic behavior indicates that this population is under some stress. The majority of this stress is most likely due to the presence of the juvenile Woody, as the majority of agonism was in response to his actions, indicating that the level of stress is probably quite normal for the population, as it is normal for juveniles to be very active.

The lemurs observed in this study did not reproduce behaviors shown in the ethograms obtained from field studies [Jolly 1969, Richard 1978] (Table 3). This is most likely due to the diminished troop size that was on exhibit. Little affiliative behavior was observed, even after the arrival of Lulu. Emily and Shorty groomed each other at times, and were twice observed playing with each other. Lulu and Emily were also observed grooming each other. Most of the other interactions between individuals comprised of the physical contact derived from sleeping in a huddle. In addition, very little agonistic behavior was observed between individuals. The main form of agonism observed was displacement activity, a gentle reminder of who ranks where in the lemur hierarchy.

Upon the arrival of Lulu, head rolling, which is a form of agonistic behavior [Jackal, communication] was observed by both Emily and Lulu.

<table>
<thead>
<tr>
<th></th>
<th>Total agonistic interactions/ 900 second period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jolly field study (1969)*</td>
<td>114</td>
</tr>
<tr>
<td>Richard field study (1978)*</td>
<td>21</td>
</tr>
<tr>
<td>Sibley and Krauss captive study (this study)</td>
<td>&gt;1</td>
</tr>
</tbody>
</table>

**Table 4. Agonistic behavior observed in lemurs.** "Data has been converted as Jolly and Richard recorded agonistic behavior exhibited per every hour of observation."
These instances of agonistic behavior are not those that were most frequently highlighted by lemur researchers [Jolly 1969, Richard 1978]. The most typical agonistic behaviors observed in nature consisted of stink-fights between male individuals, as well as feinting, or jumping, at other individuals. In addition, vocalization was frequently personal observed during agonistic displays. Neither stink fights, feinting at other individuals, nor vocalization were observed. This is possibly due to the small troop size on exhibit, as well as the fact that none of the animals were reared in the wild. Emily was a pet before she joined Zoo New England, and Shorty had been transferred to several zoos throughout his life. Lulu had spent a year in confinement previous to her returning to the Franklin Park Zoo’s exhibit. All of these factors contribute to the low levels of social behaviors observed. This population is not an accurate representation of wild lemurs, and most likely is not typical of captive lemurs. This is one of the most important reasons that Zoo New England is attempting to form a breeding colony at this zoo. It will increase the quality of life of the lemurs as well as the level of interest of spectators in the zoo.

The level of agonistic behavior indicates that the population is under abnormally low levels of stress. This is perhaps healthy for the individuals, however, the population also seems to lack many stimuli sparking affiliative behavior, which leads to increased mental health in individuals [Harlow and Harlow, 1962]. The stimulation that would be added by more adult individuals and perhaps a juvenile or two would most likely increase the amount of social behavior and therefore increase the mental health of this population.

There are several issues that this research brings to light. For example, as the age makeup of each populations was not identical, it is possible that two populations with
individuals of equivalent age would yield results different from those obtained in this experiment. It is relatively abnormal for any population to be lacking juveniles at all times, although some captive environments encounter limited success with breeding programs. In order to ascertain the most accurate levels of social and solitary behaviors, it most likely best to match the populations adult for adult, juvenile for juvenile, and so on. However, it is interesting to note that these two species of primates have different troop sizes in the wild. It is therefore valid to consider whether populations matching size in the wild or populations matching each other would elicit the most accurate results.

The field of comparative primatology seems to focus on the differences in learning, cognition, and intelligence. It is apparent that there is no simple taxonomic relationship between learning and cognition [Fobes and King, 1987; Mitchell and Edwin, 1987]. However, there are few, if any, studies that compare the behaviors of different taxa of primates in the manner of this study. Prosimians and Old World Monkeys are separated by approximately 30 million years of evolution [DeVore, 1965], so it is very interesting to determine what characteristics have been retained, enhanced, and lost throughout time. More studies, either literature based or field based, are necessary to compile data and thereby amplify the field of comparative primatology.

As the size of the mandrills’ was smaller than the lemurs, it is also valid to consider the effect that equivalent exhibit size would have on a comparison like this one. It is also appropriate to consider whether the current exhibit sizes are proportionate to the range of the species in the wild. As ring-tailed lemurs live in dry forests in Madagascar, and have a range twice as great as other lemurs [Doyle and Martin, 1979], it is possible that lemurs require a greater range in order to each adequate sustenance than do the
mandrills. The mandrills live in the rain forests of Gabon, and due to the high availability of food and no severe food shortages [Preston-Mafham and Preston-Mafham, 1992], it is likely they have a small range. If this prediction is true, that is, if mandrills require less acreage for a greater number of individuals than the lemurs, the exhibits would most likely be more accurate, and therefore elicit more accurate observations. This requires information that is not currently at hand due to the small number of studies performed on mandrills in the wild as well as the fact that mandrills tend to travel in very large groups, making identification of individuals very difficult.

Nonetheless, the agonism and activity patterns of the lemurs and mandrills give significant insight into the two populations. This study encourages further observations of primate populations to determine an accurate percentage of agonistic behaviors, particularly of mandrills in the wild, since very little is known about them.

**Conclusions**

In summary, the two populations observed exhibited significantly different amounts of agonistic and active behaviors. The population that was the most active was also the most agonistic. These results appear to depend on the age makeup of the individuals in the exhibit, as well as the size of the exhibit. Unfortunately, there are no pre-existing levels of agonistic behavior recorded as normal for these two species, warranting further research into the matter. This analysis supports what others have suggested: that primate behavior is influenced strongly by their environment and its cohabitants.
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