NORTHERN ILLINOIS UNIVERSITY

Effects of Enrichment on Captive Ring-Tailed Lemurs

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By

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Abstract:

This research aimed to examine the effects of different enrichment devices on the behavior of a group of four captive ring-tailed lemurs at Summerfield Zoo in Belvidere, IL. Enrichment has been shown to increase the overall health and wellbeing of animals living in captivity by encouraging natural behaviors while discouraging harmful behaviors. This project studied the reactions the lemurs had to four different feeding enrichment devices over a seven-week period. Lemurs sat and slept significantly more and interacted less during the pre-enrichment period (17%, 61%, 0% respectively) as compared to the during-enrichment period (34%, 0%, 33%) (T=5.74, p <0.001, T=14.17. p <0.001, T=6.64, p < 0.001). Lemurs also sat more and slept less during the post-enrichment (28%, 30%) than during the pre-enrichment period (17%, 61%) (T=-3.69, p<0.01, T=8.10, p<0.001). There were no significant differences in the effects of the four different enrichment devices on the lemurs’ behavior. As wild ring-tailed lemurs are active during most of the day, the devices successfully increased naturalistic behaviors, and these effects persisted even in the post-enrichment period. These results suggest that zoo and sanctuary animals can benefit from exposure to different enrichment devices, and that even simple, inexpensive enrichment devices are effective and should be included in the daily care of all animals.

Study Objective:

In this project, I planned to examine the effects of enrichment devices on captive primates, specifically ring-tailed lemurs (Lemur catta). I hoped to determine whether enrichment devices can reduce abnormal behaviors in captive populations of ring-tailed lemurs. To do this, I
introduced four different enrichment devices to the four ring-tailed lemurs that reside at Summerfield Zoo in Belvidere, Illinois. I observed and recorded the lemurs’ behavior prior to the introduction of the enrichment device and compared that to their behavior while they interacted with the device and immediately after the devices were taken away.

Enrichment can increase the overall wellbeing of animals living in captivity by providing animals a way to decrease the mundanity of living in a zoo (Jennings and Prescott, 2009). Enrichment is particularly essential for captive primates, as it can encourage them to engage in activities like their wild counterparts and reduce the risk of abnormal behaviors which may emerge if animals are under-stimulated (Gould et al., 2003). Primate enrichment is commonly provided in the form of social, visual, auditory and/or olfactory stimulation, and/or dietary variety/challenges. Enrichment can promote natural feeding behavior, bolster positive group interactions, and encourage exercise (Gould et al., 2003). Currently the lemurs at Summerfield Zoo are provided with two types of enrichment: olfactory enrichment is provided in the form of dried kitchen spices sprinkled in their enclosure every few days, and baby toys and ropes are hanging in their enclosure to encourage movement. While these provide the lemurs with some stimulation, more enrichment devices of different varieties may improve the overall wellbeing of the group. Any enrichment devices used in this study will be donated to the lemurs at Summerfield Zoo at the conclusion of this project.
**Introduction:**

Lemurs are strepsirrhine primates which are found only on the island of Madagascar. Lemurs are thought to have arrived on the island 56 million of years ago and subsequently experienced a very successful adaptive radiation into 15 different genera and around 100 species (IUCN, 2014). Ring-tailed lemurs are the most well studied lemur and the most common lemur found in captivity (Taylor, 2009). Due to habitat destruction and degradation, ring-tailed lemurs, like the majority of lemurs, were listed as Endangered on the IUCN Redlist in 2012 (IUCN, 2014). Since then, the number of lemurs in captivity has grown with the goal of reintroducing these captive animals into the wild one day (Taylor, 2009).

The most undeniable characteristic of ring-tailed lemurs is their long black and white striped tails which they hold almost vertically as they move around on the ground. This species is the most terrestrial of all lemurs, but they do sometimes travel above ground and sleep in trees every night (Hedge, 2005). They have a diverse diet in the wild consisting of ripe fruits, leaves, flowers, gums, invertebrates, and some small lizards or birds (Fenn, n.d.). Research on wild ring-tailed lemurs indicate that animals wake just before dawn and sunbathe as the sun rises to help them thermoregulate (Wright, 1999). After sunbathing, they will begin to forage and feed. This is followed by a midday nap which leads to more foraging and feeding. After an intense feeding session in the late afternoon, the group usually travels back to the sleeping tree where they rest for the remainder of the night (Gould et al., 2003). Lemurs spend approximately 25% of active time foraging and feeding, so it is important to offer feeding enrichment to captive lemurs to simulate natural behavior (Taylor, 2009). These diurnal primates live in complex social groups comprised of females of the same natal group and their offspring (Taylor, 2009). Unlike most
primates, female ring-tailed lemurs are dominant to males, and the group is led by a single
dominant female (Wright, 1999). These lemurs rely heavily on olfactory communication in
which both males and females use scent glands to mark their territory and communicate with one
another (Hedge, 2005).

Ring-tailed lemurs and other prosimians may find it hard to manipulate certain
enrichment devices since they are less dexterous than other primates with opposable thumbs, so
enrichment devices must consider their manipulative abilities (Taylor, 2009). Due to lemurs’
relatively low basal metabolic rate, obesity can be a major issue in captivity (Goodchild and
Schwitzer, 2008). Offering a balanced diet through various feeding methods can encourage more
active foraging which in turn may reduce stereotypical behaviors (Goodchild and Schwitzer,
2008). Although there has been a lot of research published on enrichment for other primates such
as rhesus macaques and chimpanzees (e.g. puzzle feeders and mirrors: (Jennings and Prescott,
2009)) there are no published studies on ring-tailed lemur enrichment. The care manuals and
guidebooks I was able to access offered general guidelines for enrichment but provide very little
details about actual enrichment devices which have been used or their effectiveness. Therefore, I
designed my study to investigate the effects of four different feeding enrichment devices.

**Methods:**

I used group scans at 5-minute intervals to gather my data. I recorded the first behavior
observed for all visible group members during the first 30 seconds of each sample period. Before
I began the experiment, I observed the group for six hours without offering any enrichment
devices or altering their normal routine to document their normal activity budget. I documented
each group member’s activity in seven broad categories: rest = laying/sleeping/sitting,
interaction=interacting with any toy or enrichment device, movement=
walking/leaping/running/jumping, consume= eating/drinking/foraging, social =
fighting/grooming, communicate=vocalizing/scent marking, abnormal behavior=pacing/picking
off fur/biting at limbs. I also took detailed notes to define the animals’ activity more specifically
(e.g. rest= sleeping). During my observation of the lemurs’ while they were provided
experimental enrichment devices, I documented their activity using the same categories and
noted how often and for how long the lemurs interacted with the various devices.

I provided four different devices for the lemurs to interact with, all of which involved
food: 1) suet bird feeders filled with food which I suspended off the ground to encourage the
lemurs to reach for the treats, 2) rubber Kong dog toys filled with honey and raisins to encourage
the lemurs to use their digits to scoop the food out, 3) one-foot-by-one-foot turf square filled
with bird seed, raisins, and finely chopped fruits to encourage the lemurs to forage and pick out
the treats, and 4) small whiffle balls filled with chopped up dried fruit to encourage the lemurs to
shake the device in order to get the treats out. Each enrichment device was offered on at least
four different days on a random rotating schedule.

Each observation period included 30 minutes of observation before introducing the
enrichment device, then 30 minutes of observation while the enrichment device was in the
lemurs’ enclosure, and 30 minutes of observation after the device was removed. I repeated this
process three times a week for seven weeks. After 33 hours of data collection, I analyzed the data
to decide which, if any, enrichment devices I used were successful in decreasing stereotypical
captive primate behaviors and increasing natural behaviors in the ring-tailed lemurs of
Summerfield Zoo.
I pooled the activity data collected for the entire group for each day for three periods: the time before the device was given (pre), while they had the device in their enclosure (during), and after the device was removed (post). I also studied the behavior of the group for the three periods, examining the results of each enrichment device separately. And finally, I examined each individual during the three periods, to determine if there were differences between group members. I used the paired t-tests to compare daily activities during the “pre”, “during” and “post” periods, and adjusted the p-values to account for multiple comparisons of the same data set (the Bonferroni correction factor). I used the $X^2$ test for independence to further determine if the enrichment devices produced different effects, and to determine if individual lemurs responded differently to the devices. For the $X^2$ tests I also adjusted the p-values to account for multiple comparisons of the same data set (the Bonferroni correction factor).

**Results**

The activity budget for the whole group during the 6-hour observation day before the enrichment experiment began showed that 74% of their time was spent sleeping (Figure 1). While it is not specifically included in the activity budget, grooming and eating made up most of the “other” category. Although there were enrichment items in the enclosure prior to my research, I did not document a single interaction with an enrichment item during this observation time.
On each day of the experiment, I observed the lemurs for 30 minutes prior to introducing an enrichment item, hereafter referred to as the “pre-enrichment period”. The animal’s activity budget during these pre-enrichment periods is similar to the activity budget I calculated during
my 6-hour pre-experiment observation: group members slept most of the time. Other activities documented less frequently include sitting, moving around the enclosure and “other” (which mostly included eating and grooming).

Figure 3. Whole Group Activity Budget While Enrichment was Offered During the Entire Study

During the 30 minutes that an enrichment device was offered to the group (hereafter referred to as the “During” phase) there were no documented occurrences of sleep. Instead, animals spent their time sitting, moving, and interaction with the enrichment device (Figure 3).

Figure 4. Whole Group Activity Budget After Enrichment was Removed, (Post-Enrichment Periods) for the Entire Study
In the 30 minutes after enrichment devices were removed, hereafter referred to as the “post-enrichment period”, the group went back to resting. As opposed to the pre-enrichment periods, the lemurs did occasionally interact with the enrichment devices that permanently remained in the enclosure after the experimental enrichment devices were taken away. Much of the “other” activity was grooming themselves and each other, a common behavior before the lemurs fell asleep.

I compared the behavior of group members during the pre-enrichment phase and the enrichment (“during”) phase, and the pre-enrichment phase to the post-enrichment phase (Table 1). Lemurs sat and slept more and interacted less during the pre-enrichment period (17%, 61%, 0% respectively) as compared to the during-enrichment period (34%, 0%, 33%). Lemurs also sat more and slept less during the post-enrichment (28%, 30%) than during the pre-enrichment period (17%, 61%) (Table 1).

Table 1. T-Test Results Comparing Activities Before (pre), During and After (post) for All Enrichment Days

<table>
<thead>
<tr>
<th>Group</th>
<th>Sit</th>
<th>Sleep</th>
<th>Move</th>
<th>Interact</th>
<th>Sit</th>
<th>Sleep</th>
<th>Move</th>
<th>Interact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T=-5.74202</td>
<td>T = 14.16927</td>
<td>T = -2.86199</td>
<td>T = -6.64106</td>
<td>T = -3.68896</td>
<td>T = 8.10339</td>
<td>T = -0.40161</td>
<td>T = -1.51792</td>
</tr>
<tr>
<td></td>
<td>p = 3.89E-05*</td>
<td>p = 4.33E-10*</td>
<td>p = 0.011875</td>
<td>p = 7.86E-06*</td>
<td>p = 0.002188*</td>
<td>p = 7.35E-07*</td>
<td>p = 0.693635</td>
<td>p = 0.149827</td>
</tr>
</tbody>
</table>

* with the Bonferroni correction factor a p-value of less than 0.006 is considered significant.
I also compared the number of interactions the lemurs had with the enrichment devices during the lemurs’ first exposure to it against the lemurs’ fourth exposure to the same device: there were no significant differences between the first and fourth exposure ($t = 0.780998, p = 0.491766$).

I also examined whether any one enrichment device encouraged more interactive behavior during the enrichment period, however, I found no significant differences between the lemurs’ behavior while exposed to the different enrichment devices (Table 2).

### Table 2. Comparison of Enrichment Types and Activity During Enrichment Using Chi-Squared Test for Independence

<table>
<thead>
<tr>
<th></th>
<th>Kong</th>
<th>Turf</th>
<th>Suet</th>
<th>Whiffle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kong</td>
<td>-</td>
<td>X2 = 0.000230523, p = 0.999885</td>
<td>X2 = 4.68665E-07, p = 1</td>
<td>X2 = 0.000474944, p = 0.999763</td>
</tr>
<tr>
<td>Turf</td>
<td>-</td>
<td>-</td>
<td>X2 = 0.012129422, p = 0.993954</td>
<td>X2 = 0.001157065, p = 0.999422</td>
</tr>
<tr>
<td>Suet</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X2 = 0.01338627, p = 0.993329</td>
</tr>
<tr>
<td>Whiffle</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Similarly, I examined if any one enrichment device encouraged more interaction with the permanent enrichment devices after the “during enrichment” period but found no significant differences (Table 3).
Table 3. Comparison of Enrichment Types and Activity POST Enrichment Using Chi-Squared Test for Independence

<table>
<thead>
<tr>
<th></th>
<th>Kong</th>
<th>Turf</th>
<th>Suet</th>
<th>Whiffle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kong</td>
<td>-</td>
<td>X2 = 0.020468076, p = 0.98981815</td>
<td>X2 = 0.005247518, p = 0.99737968</td>
<td>X2 = 0.000110435, p = 0.99994478</td>
</tr>
<tr>
<td>Turf</td>
<td>-</td>
<td>-</td>
<td>X2 = 0.645648526, p = 0.72410109</td>
<td>X2 = 4.57193E-07, p = 0.99999977</td>
</tr>
<tr>
<td>Suet</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X2 = 2.37788E-08, p = 0.99999999</td>
</tr>
<tr>
<td>Whiffle</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 5. Activity Budgets for Each Lemur During the Pre-Enrichment Period

*IN= Interaction, MV= Movement, RE= Rest

I also examined whether there were individual differences in the lemur’s activity budgets. I compared the lemurs’ activities during the pre-enrichment period (Figure 5). The male NM
engaged in the most movement (17%) and the most interaction (1%) as compared to the other animals. The male IM and female FF had the highest percentages of resting (97% and 96% respectively).

I also compared each individual lemur’s activity before enrichment compared to during enrichment and before enrichment compared to after enrichment to determine if the enrichment affected the lemurs differently. The female F2 engaged in significantly more sitting pre-enrichment versus during-enrichment (Table 4). The male NM engaged in significantly less movement pre-enrichment versus during-enrichment. The male IM slept significantly more pre-enrichment versus during-enrichment. All other comparisons were not statistically significant.

Table 4. T-Test results Comparing Activities Pre, During and Post All Enrichment per Individual

<table>
<thead>
<tr>
<th>Animal</th>
<th>Pre vs During</th>
<th>Pre vs Post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sit</td>
<td>Sleep</td>
</tr>
<tr>
<td>FF</td>
<td>T = -4.33333, p = 0.022669</td>
<td>T = 5.435615, p = 0.012223</td>
</tr>
<tr>
<td>F2</td>
<td>T = -7.50555, p = 0.004901*</td>
<td>T = 9.857143, p = 0.00222*</td>
</tr>
<tr>
<td>NM</td>
<td>T = -0.73113, p = 0.5032453</td>
<td>T = 5.032453, p = -11</td>
</tr>
</tbody>
</table>
Discussion

Mental stimulation in the form of varied enrichment strategies is essential to the overall health of captive animals, especially primates. Proper enrichment has been shown to increase natural behaviors, decrease abnormal behaviors, and reduce the risk of obesity in captive animals. My research has supported this by showing overall trends of decreased resting time and increased activity levels not only while the lemurs had the enrichment devices, but also after the devices were removed. The lemurs did not seem to prefer any one enrichment item over another, nor did the number of times they had seen a particular device change their reaction to it.

Upon investigation of the groups’ activity as a whole, I saw a dramatic decrease in the occurrence of sleep while the lemurs had an experimental enrichment device in their enclosure. During this time there were zero occurrences of sleep as opposed to the 61% of time spent sleeping “pre-enrichment”. The frequencies with which lemurs interacted and moved also increased substantially “during-enrichment” as well as “post-enrichment” meaning the devices were also successful long-term. The amount of time the lemurs spent sleeping “post-enrichment” dropped by half, meaning the devices were successful in reducing the time spent sleeping and increasing other activities such as physical exercise and social interaction. The lemurs also

<table>
<thead>
<tr>
<th></th>
<th>0.517632</th>
<th>0.015122</th>
<th>0.001609 *</th>
<th>0.006165</th>
<th>p = 0.49340</th>
<th>p = 0.07827</th>
<th>0.39102</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>( T = -3.91965 ) &amp; ( p = 0.029532 )</td>
<td>( T = 7.980804 ) &amp; ( p = 0.004105 ) *</td>
<td>( T = -0.18157 ) &amp; ( p = 0.867496 )</td>
<td>( T = 6.35085 ) &amp; ( p = 0.007898 )</td>
<td>( T = 1.72609 ) &amp; ( p = 0.18279 )</td>
<td>( T = 4.01548 ) &amp; ( p = 0.02772 )</td>
<td>( T = 5 ) &amp; ( p = 0.01539 )</td>
</tr>
</tbody>
</table>

* a p-value of less than 0.006 was considered to be statistically significant bearing in mind the Bonferroni correction factor.
interacted with their permanent enrichment devices more often after they were exposed to any of the experimental enrichment devices. This suggests that the temporary enrichment devices encouraged the lemurs to be more active even after the new items were removed, indicating longer-term benefits for the animals.

Individual lemurs varied in their overall behavior, and also in their response to the enrichment. One male, NM, was more active than any of his group mates. He also was the most engaged with the enrichment devices, and he spent significantly more time moving during enrichment than during the pre-enrichment period. Although other animals were less active, even they responded to the enrichment devices. The female F2 engaged in significantly more sitting pre-enrichment versus during-enrichment. The male IM slept significantly more pre-enrichment versus during-enrichment. Thus, although individual responses varied, all were positively affected by the introduction of the new enrichment.

My results suggest that enrichment provides important benefits to the lemurs, and I recommend additional research to build upon my pilot study. First, I recommend extending the duration of the project and observing the animals for a longer period of time before, during, and after enrichment. Furthermore, I recommend more trials with each device to see if any particular device had a different effect on the lemurs’ activity. I would also incorporate more enrichment device options into the rotation to better determine which devices work and which do not. It is possible that the lemurs would eventually lose interest in certain devices, so it may be necessary to have a full arsenal of novel toys and treats to keep them entertained long-term.

Zoos and sanctuaries can easily incorporate an enrichment routine into the daily care of many animals including lemurs and other primates. I was able to purchase all of my supplies for this project for under $50.00, thus my results clearly demonstrate that simple, inexpensive,
devices are effective. I would recommend Summerfield Zoo continues to use these enrichment devices for the ring-tailed lemurs as well as modified versions for the pygmy marmosets, cotton-top tamarins, vervet monkey, and coatimundis.

**References:**


