Changing Repetitive Behaviors in Captive Andean Bears (*Tremarctos ornatus*)

Matt Oskielunas
Abstract

Zoos across the world run into behavioral problems with their captive animals as a result of species not having proper living space and enrichment opportunities. The goal of this study was to determine whether enrichment activities can decrease the frequency of a repetitive head rolling behavior in a 21 year old female Andean bear (*Tremarctos ornatus*) at the Racine Zoo, Racine, Wisconsin. Observations of behaviors were recorded in the morning and afternoon for a two week baseline and a two week enrichment period. Though overall data analysis showed no significant change in behavior after introducing enrichment, after three days of initial adjustment to stimuli, there was a significant reduction in head rolling. Therefore, introducing enrichment is an effective way to reduce repetitive head rolling behavior in captive *T. ornatus*.

Introduction

Behavioral problems of animals in zoos are often difficult to correct. In part, this is because it is difficult to recreate, in captivity, the vast range that these animals inhabit in the wild. For example Andean bears (*Tremarctos ornatus*), which are native to the Andes Mountains, need a large amount of space to survive well in captivity. In the wild, male *T. ornatus* have an average home range of 108 km squared and females have an average of 27 km squared (www.andeanbear.org). It is the goal for modern zoos to improve animal management and create exhibits that promote natural behaviors and prevent or reduce repetitive behaviors (Fischbacher & Schmid, 1999).

Like many bears in zoos the female bear in this study has a repetitive head rolling behavior. The repetitive behavior, or stereotypy, may develop due to frustration, unavoidable stress or fear, restraint or lack of stimulation (Mason, 1990). Her behavior is not life threatening, it does not give a positive perception to the public. With the right treatments, like introducing enrichment tools, the repetitive behaviors she displays should be able to be reduced by a considerable amount (Altman, 1999).

The Association of Zoos and Aquariums is a non-profit organization that tries to help ensure that zoos advance and continue to improve their animal care, wildlife conservation, education and science. Establishing and promoting high standards of animal care and welfare (www.aza.org) is one of the points of the AZA’s mission
statement. The AZA accredits a zoo if it meets the proper standard set by the AZA and passes inspection by their experts. When the AZA evaluates a zoo, they check whether the zoo "meets AZA's standards for animal management and care, including living environments, social groupings, health, and nutrition. The AZA also ensures that animals are provided with enrichment that stimulates each animal's natural behavior and provides variety in their daily routine" (www.aza.org).

Creating an exhibit that is adequate for a large carnivorous mammal without sacrificing visitors viewing experience is a difficult task. In some cases, confinement in small areas can impact how those animals later deal with changes to their environment. For example, Hancocks (1980) describes a tiger that was born and raised in an exhibit with nothing but a concrete floor. When the tiger was released into an outdoor natural environment, it began to stumble and walk erratically because it was not accustomed to walking on natural terrain.

Many zoos have been successful housing animals with favorable outcomes such as reproduction. For example, the Brookfield Zoo in Illinois has been successful in the reproduction of its species, with the notable births of polar bears, Amur tigers, reticulated giraffes, and rhinoceros. Specifically, the female polar bear (who was born at the Brookfield Zoo) has reared five litters of cubs (www.brookfieldzoo.org).

In captivity, animals are often unable to engage in a wide array of activities characteristic of their counterparts who live in the wild. A proper enclosure is conducive for activity and includes cage furnishings and manipulable objects that provide suitable opportunities for an increased range of behaviors (Altman, 1999). Further, the best exhibits integrate the ecological needs of the individual species into the exhibit.

The Racine Zoo currently houses a twenty-one year old female and eighteen year old male T. ornatus. They were both born in captivity at different zoos and have been kept in captivity their entire life. They are housed together and share the exhibit and are regularly on exhibit together. The bears exhibit schedule is randomly set, but neither one can be off exhibit for consecutive days. Indoors, they are kept in two different stalls with concrete floors covered in hay and a cage to separate them from each other and keepers. This indoor exhibit setup is standard for most zoos that have indoor housing. This indoor setup is conducive for easier cleaning and overall care of large bears.
Bears in Zoos

Almost every zoo that is accredited by the Association of Zoos & Aquariums has one or species of bear. Although bears are very popular, perhaps because of their colossal stature, bear exhibits are often lacking (Forthman et al., 1992). Though bears have large home ranges, in captivity they are usually confined to moated grottos. The grottos are typically constructed with Gunite (a type of concrete) and contain a swimming pool, rocks, and logs (Forthman et al., 1992). The more space a bear is given in the exhibit the better. The Minnesota Zoo’s grizzly bear exhibit is 13,603 sq. ft; however the exhibit cost was over 23 million dollars (www.minnesotazoo.org). Bear exhibits are usually species specific in order to meet the proper needs of the animal living in it, and the cost does not have to be millions of dollars. For example, *T. ornatus* live in mountain habitats exceeding elevations of 3,658 meters and as low as 457 meters, they do not need a large exhibit.

Andean Bear Ecology

*T. ornatus* is a solitary bear that come together for reproductive purposes. By being a solitary bear they are not constrained by competition with others around them (Paisley & Garshelis, 2006). *T. ornatus* share many characteristics with other tropical bears, including the Sun bear and the Sloth bear, but they are unique because they are the only extant bear that is short faced, and they have white markings around their eyes that resemble spectacles (which is how they receive the name “Spectacled Bear”). These markings also extend to their muzzle, throat, and sometimes chest (animaldiversity.org), and no two bears have identical markings, making it easier for scientists to identify individuals in the wild (www.phoenixzoo.org). *T. ornatus* are average sized, and like many mammals, males are larger than the females. Males have an average length of 5-6 feet and weight of 250-350 pounds. Females are 30-40% smaller than the males, weighing in at 150-200 pounds with a length of 3 ½-4 ½ feet long (Burnie & Wilson, 2005).

Bears in general are very skilled climbers, but only the smaller species can be supported in trees. *T. ornatus* frequently are found in trees where they feed on nuts, fruit,
and various plant materials (Peyton, 1980). Their large claws allow them to skillfully climb up and down trees, and even create resting platforms in trees which they may stay in for a couple of days. In order to create these platforms, *T. ornatus* bends and breaks branches to make them into a nest. The large claws of the *T. ornatus* are not the only physiological adaptation they have. They have plantigrade feet, which means both heel and toe touch the ground as they walk. *T. ornatus* use each of their physiological features to take full advantage of their different biomes they inhabit.

The cloud forest is a completely self sustaining biome that has everything *T. ornatus* need to flourish. The moisture that is created by the forest is the perfect environment for mosses, ferns, and epiphytes; one of the staples of the *T. ornatus* diet. The abundance of food and consistent temperatures in their habitat means the bears have no need to hibernate in contrast to the temperate bears do. The heavily forested areas that *T. ornatus* inhabits allows for them to in turn be heavily covered and unseen to humans.

*T. ornatus* are not easy to locate in the wild, so this leads to people believe that they are nocturnal and/or crepuscular (active in the evening into the night) creatures, but in fact they are not (Paisley & Garshelis, 2006). Paisley and Garshelis conducted a radio collar study on two captive release bears in Bolivia and found that the two bears were strongly diurnal, with little activity during the hours of darkness (Paisley & Garshelis, 2006). They found that the highest periods of movement were mid-morning and early evening with about 90% of activity. They also compared the nocturnal and diurnal habits with the activity during wet and dry seasons. The bears still had a higher rate of activity during the day, but the exhibited considerably more daily activity during the dry season, with 91% compared to 81% in the rainy season (Paisley & Garshelis, 2006). Even though most of the foods are available both day and night, diurnal foraging enables bears to use their sense of sight to forage for food rather than smell during the night (Paisley & Garshelis, 2006).

**Food Habits**

Foraging for food is an essential daily activity for *T. ornatus*. They are 95% herbivorous, with the majority of their diet consisting of fruits, bromeliad hearts, and various plant materials (Peyton, 1980). They do ingest meat, but usually any meat they
consume is in the form of carrion most likely provided by the Puma. Puma’s reside in the same habitat, and they were responsible for 75 attacks on livestock in the Central Andes in 2004 (Payan, 2004). Often *T. ornatus* is wrongly blamed for the livestock attacks. The only other problems that humans have with *T. ornatus* are corn farmers. Andean bears have quite the appetite for corn, and were found to raid fields at very odd times. “Campesinos also reported that bears make daytime raids on cornfields during rainstorms, taking advantage of the absence of humans” (Peyton, 1980). *T. ornatus* are smart enough to figure out ways to get around the crop guards who chase them off the corn, but do not kill them. Only some *T. ornatus* are able to raid corn fields when the pickings get slim between fruit ripening periods. For the most part they feast on a number of species of Bromeliads. Evidence had shown that assorted Bromeliads make up 11% of their diet, which is in the majority of what they eat (Peyton, 1980). *T. ornatus* are meticulous eaters when they are consuming Bromeliads. They use their large claws to tear off the leaves, and then continue to eat just the white hearts at the base of the plant (Peyton, 1980). They have a morphologically different skull that is more closely related to the *Ailuropoda melanoleuca*. Their adapted skull enhances their mastication capabilities, and allows them to have a large number of foods on their menu. *T. ornatus* diet consists of highly fibrous foods like bromeliads, so they need to be able to chew rough textured foods (Paisley & Garshelis, 2006). Their tough jaws and adapted digestive system allows them to be able to consume and digest the fibrous Bromeliads. The rest of their diet is not very complex, and for the most part they are generalists. *T. ornatus* consume a large number of different fruits, plant materials, and some various animal materials. They consume a large number of different fruits from trees like Capparis and Ficus. The fig is the fruit of the ficus tree, and makes up the majority of the diet for *T. ornatus* and almost every omnivorous or herbivorous animal in the Andes forests. *T. ornatus* also eat cactus fruit, shrub berries, palm fronds, and corn. The animal materials they eat are insects, small rodents, and honey bee hives. Honey, along with multiple fruits and vegetables, is commonly fed to *T. ornatus*, and other bears in captivity.
Zoo Diet

Zoo diets for *T. ornatus* are simple and not nearly as diverse as diets in the wild. Like other species of bears in zoos, *T. ornatus* is fed frozen fish, meat, fruits, and vegetables (www.brookfieldzoo.org) along with a supplement called omnivore diet or bear chow. This is similar to a dry dog food, full of vitamins, minerals, and grains (www.zupreem.com). This makes up the base of captive bear diet, because it is the most efficient and effective way to administer the proper nutrients that a very large mammal like a bear needs. *T. ornatus* also get their fill of fruits while in captive settings, with fruits and vegetables making up the rest of their diet. Specifically, they are given apples, grapes, carrots, potatoes, oranges, pumpkin, and bread (www.phoenixzoo.org). These are not the fruits that *T. ornatus* would consume in the wild, but they are the most accessible and cost effective for zoos. The key to zoo diets is not what is being given, because zoos will fulfill nutritional needs, the key is how the diet is given. Placing diets in enrichment or with enrichment tools are ways that zoos can distribute a diet.

Enrichment

Enrichment is using materials and objects to improve the quality of life of captive animals and promote natural behaviors. For most mammals that reside in zoos, enrichment is extremely important due to the level of intelligence they possess. Bears are highly intelligent animals, and a study in 1989 and 1990 by Dr. Debra L. Forthman demonstrated this intelligence when a sound activated fish catapult was designed in order to allow *U. maritimus* to vocalize into a microphone and receive a fish treat (Forthman, Elder, Bakeman, Kurkowski, Noble, and Winslow, 1992). When zoo diets are administered, parts of them are done using enrichment activities. Gorillas at the Woodland Park Zoo were given food in paper bags or cardboard boxes as enrichment, which prolonged the discovery and eating time (Hancocks, 1980). Enrichment in zoos is a method that continues to grow, because there is no single correct way to use it. Enrichment has expanded to any environmental variable or object that can positively impact a captive animal’s perception of its world (Shepherdson, 1992).

In the case of *T. ornatus* enrichment, very few methods have been reported. Since they are a bear that naturally spends a lot of time climbing, *T. ornatus* exhibits commonly
have climbing apparatuses in the form of large trees and tree limbs. The Jersey Zoo in England takes *T. ornatus* natural climbing habits a step further and mimics their ability to create tree nests. In nature, *T. ornatus* bend over branches in trees and create platforms that act as nests (Peyton, 1980). The Jersey Zoo mimicked this behavior and created a giant hammock created from fire hoses. Forty millimeter hoses were cut and weaved to create the hammock the hung in the trees in the bear’s exhibit. Keepers at the Jersey Zoo found that after the hammock was installed, all of their bears but one used the hammock regularly, and one of the males refused to come out of it (Cowan, 1997). The fire hose hammock is an example of inedible objects that can be used for enrichment. Inedible objects that are used by bears are not very common, because most zoos use some type of feeding method for enrichment, but inedible objects have proven to work very well (Altman, 1999).

In 1999 Joanne D. Altman found this to be true when she tested inedible enrichment objects of three different species of bears. *T. ornatus* were given two plastic balls the size of a volleyball that were connected to a rope. The goal of having these plastic balls in the exhibit was to decrease pacing in the bears (Altman, 1999). The results of this study shows that pacing decreased from 52% to just 1% of the time after the enrichment was introduced (Altman, 1999). A 51% decrease in pacing behavior show that introducing enrichment toys can significantly reduce repetitive behaviors in *T. ornatus*. After reading the data in Altman’s study, it led me to my hypothesis.

*T. ornatus* develop repetitive behaviors in captive living space due to the lack of stimulation provided by their exhibit and lack of proper enrichment. This can be improved by creating multiple and more effective enrichment tools, like a tire hammock, multiple foraging tools, and more natural food items, to make up for the lack of natural living space.

**Methods**

**Study Area**

The study area is in Racine, WI at the Racine Zoological Gardens. It is a fairly large exhibit that is mostly grass (Shown in Figure 3). The elevation in the exhibit
gradually gets lower toward the south side of the exhibit. An artificial rock structure is featured on the east side of the exhibit that includes a small swimming pool that is accessible to the bears. The center is highest point in the exhibit and it features a large climbing tree. On the southwest side of the exhibit there is a small scratching post tree. The bear’s indoor building is located on the north side of the exhibit and has a door for the male and a door for the female bear with about 20 feet between the two. There are three areas from which the bears may be viewed. There is a balcony style viewing area on the south side of the exhibit that overlooks all but a small portion of the exhibit. There is a viewing window on the east side of the exhibit that includes the artificial rock structure and pool. The viewing window on the west side of the exhibit is the best point to view the center and north parts of the yard.

**Field Sampling Baseline**

Sampling began in mid September with a preliminary ethogram in order to identify exactly what behaviors the *T. ornatus* exhibits while she is on exhibit. An ethogram defines the specific behaviors that the study subject displays so they can be universally recognized. The specific behaviors I looked for are described on the ethogram in figure 1. I conducted this preliminary study for a week to get a baseline so I could identify behaviors to mark in my primary study. I collected my data using a check sheet to collect instantaneous behavior samples, which are based on the ethogram behaviors. My data collection sheet is displayed in figure 2. The data sheet has a section that indicates which quadrant the bear is in at the minute of observation. The quadrants are defined on the exhibit map in figure 3. I conducted three weeks of data collection previous to introducing the new enrichment items, and three weeks of data collection after the new enrichment items are introduced. My daily observation time where one hour in total time length, once in the morning and once in the afternoon. Every minute of the hour I marked an X on the data sheet that indicates what behavior the bear is displaying. There were 120 observations each day and 840 total observations for the week.

**Enrichment Treatments Post Baseline**

After the initial baseline period, the bears received enrichment everyday in the
morning and afternoon. When the bears were on exhibit together they had equal opportunities to use enrichment. Feeding enrichment included parts of the diet put into feeding balls, milk jugs, cardboard boxes, and in brush piles. Non food enrichment included perfume sprayed throughout the exhibit, tire hammock, bird songs from a radio, and climbing tree. Examples of some are shown in the appendix.

**Data Analysis**

Chi-squared analysis was used to compare behavior before and after the enrichment treatment. Chi-squared contingency tables were also used to find different behavior patterns among groups.

**Results**

The chi-squared baseline and chi-squared enrichment data showed significant differences in preferred behaviors, but not in non-preferred behaviors (Shown in Figure 4). After new enrichment was introduced, the percentage of time displaying preferred behaviors jumped from 7.4% to 15.4% (Figure 5 and 6). The non-preferred behaviors showed no significant differences between baseline and enrichment periods. The results are shown in Figure 5 and 6, and none of the behaviors significantly increased or decreased. The head rolling went from 9.5% during baseline to 9.2% during enrichment.

On the first day of enrichment treatment she head rolled for 35 of the 60 minutes, on the second day she head rolled for 27 of the 60 minutes, and for 11 of 60 minutes the third day (Figure 7 and 8). After the first three days of new enrichment treatments, there was one observation of the female head rolling in the morning, and sixteen overall. The percent of time spent head rolling decreased from 9.5% to 2.4%. In contrast, the percent of time using enrichment increased from 7.4% to 13.5%.

The chi-squared contingency tables, shown in figure 4, report the differences in baseline and enrichment observed behaviors.

**Discussion**

Introducing enrichment to the *T. ornatus* exhibit at the Racine Zoo was beneficial, but in contrast to the hypothesis, head rolling behavior did not decline overall. Instead,
head rolling actually increased in the morning after enrichment was included in the exhibit. However, it is interesting to note that this head rolling was concentrated in just three days, and the percent of time spent head rolling decreased with time.

The first three days of the enrichment period served as an adjustment period to the new stimulus for the female bear. After the first three days, there were 56 observations of her using enrichment which was the majority of activities that she was involved in. The highest frequency of observed behaviors after the first three days of enrichment was resting. The absence of head rolling as the enrichment treatments progressed tells me that the enrichment is influencing her behavioral pattern, especially in the morning.

In the afternoon her head rolling behavior was significantly decreased from 13% to only 4%. Initially I thought that the problem was more apparent in the afternoon when she is shifting inside for the night, and it turned out to be that way. The head rolling accounted for 13% of her overall behavior during baseline afternoon observations. When comparing figures 5 and 7, it is obvious to see the difference between the total observed head rolling and the amount of head rolling after the first three days. The percentages decrease drastically from 9.2% to 2.4% between total head rolling and after the first three days. Towards the end of the enrichment observation period the female was visibly more active and stimulated by her surroundings. Although the chi-squared tests did not reject the null hypothesis, the introduction of enrichment was obviously making a difference in the female T. ornatus behaviors. Specifically, the goal of reduction of the repetitive head rolling behavior was beginning to take affect after the enrichment continued to be given. Research by Joanne Altman (1999) supports the idea that behaviors can be changed by introducing enrichment objects to captive bears.

On the other hand, during observations the interactions of the male and female T. ornatus made it apparent that they do not get along. There were times that she visibly was disturbed by him, and in one instance she was using enrichment and was violently chased off of it by the male. She followed it immediately with head rolling. Interactions between male and female bears at Zoo Zurich were very similar when the female chased off the male and he ran to the nearest wall and head rolled and paced (Fischbacher & Schmid, 1999). Whenever the male gets close (within ~10 feet) to the female, she vocalizes her dislike with him around her. She vocalized so much that it accounted for three percent of
her overall observed activity. During these encounters, the male was mostly passive except for the times he chased her off of enrichment. There have also been times where she would want to go somewhere else in the exhibit when they were out together, and she would not because she would have to cross his path. For example, she was head rolling on October 25 in the morning after the male chased her off of enrichment. She continued it with head rolling and searching to see where he was at. Between observation minutes she visibly wanted to walk past him but did not want to get in another encounter. Although enrichment does help the bear’s stay active, it also acts indirectly as a stressor when the male chases off the female.

When she was alone in the exhibit there was a number of different enrichment items, food and non-food, which she spent considerable time on. By far the most useful enrichment tool for the female was perfume. Perfume was used as scent enrichment that she smelled them and rubbed herself on the spots sprayed with perfume. On one of the days scheduled with perfume enrichment, the female used it for half of the observations. She also frequently used food enrichment, in the form of a feeding ball, which was a hard plastic ball with small holes filled with parts of her diet and milk jugs hung in the tree with part of her diet in it. Just like the non-food (perfume) enrichment, she spent a considerable amount of time using the food enrichment items.

Her extensive use of enrichment while she was alone made it apparent that the competition for enrichment with the male factored into her head rolling. When they were together the male bear would constantly chase her off of enrichment. Mason (1990) reported a case in which a female sloth bear would vomit and sway in the presence of an aggressive male. The solitary nature of *T. ornatus* is a large part of the problem the zoo is having. The bears are forced to be on exhibit together because neither one of them can be indoors for consecutive days. There is not another exhibit that the zoo can put either the male or female into. Ideally they would be separated and housed in adjacent exhibits, giving each bear their own space. Larger zoos like the Lincoln Park Zoo in Chicago house their Andean bears in two separate outdoor exhibits. The limitations of the zoos holding capacity for the male and female is contradicting their natural solitary lifestyle. If they were separated, the behaviors could very well change.
**Limiting Factors**

Despite the exhibit and housing limitations, introducing enrichment did change the repetitive behavior patterns of the female bear. The first three days of enrichment served as an adjustment period to new, unfamiliar stimulus. Once the adjustment period was over, it was easy to see that enrichment made a large difference in preferred behaviors.

This study was still limited for a number of different reasons. First, it was time limited because the baseline and enrichment data were taken in just three week increments. Ideally it would be a long term study in which the baseline and enrichment observation period would be at least two months or longer. Getting at least a month of baseline and a month of enrichment data would be the minimum time I would like to observe. With longer observation periods the data trends would be more distinct and it would be easier to report them.

Secondly, the exhibit conditions were limited because there was only one exhibit that both bears were housed in. Preferentially each bear would have their own exhibit so they can live in solitary like they do naturally. Having the presence of a much larger, dominant male was an added stressor for the female, and she would not have to share territory. It would be very hard to accomplish this at the Racine Zoo with this particular bear, because it would require either the male or female to be moved into a different exhibit that the zoo does not currently have.

Finally, the enrichment would be much more advanced and there would be a higher volume of it. Very little funding was available for the project, which limited the complexity of the enrichment. All of the enrichment items, like the tire hammock (shown in the pictures) were donated items. The majority of enrichment was simple like cardboard boxes and milk jugs. With more funding and time, tools like puzzle feeders, more extensive climbing structures, and foraging spaces could have been made. Enrichment would be able to be given more often and at a higher volume.

Given these restrictions that I encountered during this study I would make the proper changes in continued research. I would separate the male and female bears so they never come in contact. The design and methods would be the same, but the duration would be longer. I would lengthen the time of baseline and enrichment periods to try and
get more extensive data sets. I would change some of the enrichment and add to them giving the bears more variations throughout the longer time period. I would also attempt to get more funding for enrichment tools. Other than those few changes; little would differ in continuing this research.

After thoroughly analyzing the data, it was clear that introducing enrichment made a significant change in decreasing the repetitive head rolling behavior of the female *T. ornatus*. The limiting enrichment tools used leaves the door open in the future to continue the research and with more effective enrichment repetitive head rolling behaviors may be completely eliminated.

**Acknowledgements**

I would like to thank the Racine Zoological Gardens for letting me conduct this study. Beth Rich and Leigh Smith for working closely with me and changing the daily routines of theirs and other keeper’s days. I would also like to thank Dr. Tracy Gartner, Dr. Deanna Byrnes, and Dr. Scott Hegrenes for providing revision and advice for the research.
Appendix

Ethogram (Hallie)

**Preferred**
- Foraging
  - Searching for food while actively moving around exhibit
- Walking
  - Moving from one place to another
- Eating/Drinking
  - Eating or drinking
- Climbing
  - Any sort of climbing on trees or rocks
- Foraging/Eating in Tree
  - Any time she is searching for or eating food in the tree
- Using Enrichment
  - Any time she is using an enrichment object to occupy time
- Resting
  - Any time she is laying or sitting down, even perched in the tree
- Standing
  - Standing in place with no intentions of anything else
- Sniffing
  - Visibly smelling something or the air
- Searching
  - Visibly searching or keeping an eye on Diamond while laying or sitting or standing

**Non-preferred**
- Head Rolling Clockwise
  - Whenever she is sitting or standing at a door rolling her head clockwise
- Head Rolling Counter-clockwise
  - Whenever she is sitting or standing at a door rolling her head counter-clockwise
- Vocalization
  - Anytime she uses a vocalization for a reason (like when Diamond gets close)
- Pacing
  - Walking back and forth in a patterned fashion

**Notes**
Under non-preferred, clockwise and counter-clockwise because when I observed the behavior, she would only roll clockwise. Pacing is something I think she does do, because she walks between her door and Diamond’s door when she is in her repetitive behavior sort of phase. This happened when a keeper was inside feeding Diamond in the afternoon.

Figure 1
Insert Data Sheet Example Figure 2
Figure 3 - Exhibit Layout
Significance of Preferred Behaviors: from Baseline to Enrichment

<table>
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<th>Behavior</th>
<th>Baseline</th>
<th>Enrichment</th>
<th>Significantly Different</th>
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<tr>
<td>Walking</td>
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<tr>
<td>Using Enrichment</td>
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<td>Resting</td>
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<td>98</td>
<td>Yes</td>
</tr>
<tr>
<td>Sniffing</td>
<td>27</td>
<td>53</td>
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<tr>
<td></td>
<td><strong>175</strong></td>
<td><strong>367</strong></td>
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Chi-squared contingency table shows that all of the preferred behaviors significantly changed.

Significance of Non-preferred Behaviors: from Baseline to Enrichment

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<tr>
<td>Vocalizing</td>
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<tr>
<td></td>
<td><strong>135</strong></td>
<td><strong>221</strong></td>
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Chi-squared contingency table shows that the non-preferred behaviors did not significantly change.

Significance of Preferred Behaviors: Post First 3 Days of Enrichment

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<td></td>
<td><strong>135</strong></td>
<td><strong>116</strong></td>
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Chi-squared contingency table shows that there was a significant difference in Head Rolling and Vocalizing.

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Figure 4
Percent of time of preferred behaviors for the entire study

Percent of time of non-preferred behaviors for the entire study

Figure 5
Percent of time of preferred behaviors after the three days of initial head rolling

Percent of time of non-preferred behaviors after three days of initial head rolling

Figure 6
Female Bear Using Climbing Structure

Female Bear Foraging in Exhibit
Tire Hammock Enrichment Tool

Tire Hammock Enrichment Tool- Scaled with female German Shepard
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