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# Social and Environmental Factors Contributing to Stereotypic Behavior in the Spectacled Bear

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**Social and Environmental Factors Contributing to Stereotypic Behavior in the  
Spectacled Bear**

by

**Dana M. Varble**

**A Thesis Submitted in Partial Fulfillment  
of the Requirements of Zoology 493**

**Department of Zoology  
Southern Illinois University  
April 1999**

## ABSTRACT

Stereotypies have many causes and contributing factors. Often overlooked is the importance of social and environmental factors such as weather, pen design, social interaction, feeds and feeding schedule, and early childhood experiences. These factors are overlooked in favor of more concrete and testable factors such as size of the animal, pen size, age, sex, and health. This research revealed the importance of social and environmental factors in interpreting the causes of stereotypy in one captive spectacled bear (*Tremarctos ornatus*) at the St. Louis Zoo. Observational data collection was employed to attempt to gather data supporting the influence of these factors. An ethogram was constructed to aid in data collection. Observation occurred on 10 days between June and November 1998. Data were then interpreted with the aid of statistical software. Arithmetic means were calculated and employed as a means of comparing one abnormal individual to two normal bears. The stereotypies, pacing and grooming genitals, varied with time of day and other conditions. Evidence seemed to support cage design and early childhood experiences, with slight contributions from feeding methods, animal size, and sex, as the main causes of stereotypy in this bear.

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## INTRODUCTION

The time when humans first began putting animals in cages for display is unknown. Yet from that time on we have struggled to understand why captive animals behave differently than their wild counterparts. We have tried to recreate natural settings to the best of our abilities, and still the animals fail to respond to these artificial homes as they would in nature. Zoos and animal parks are more suitable for animals now than they were fifty or even ten years ago. Most animals in these parks lead happy, healthy, and stress free lives. The prevailing program of “behavioral enrichment” attempts to fill captive animals’ time with other activities to prevent stress and boredom. Carlstead et al. (1991) performed a study specifically attempting to enrich the environment of several bears. They created objects, like honey-filled logs, to encourage complex feeding behaviors similar to those of wild bears. However, not all the problems have been solved. Among the most visible of these problems is the performance of stereotypic movements, which are often said to be indicative of poor welfare or stress. Perhaps it is time that we consider other causes for this abnormality, or change further how animals are kept in captivity.

### Defining Stereotypy

Stereotypies are characterized by three things; they are repetitive, invariant movement patterns without goal or function (Carlstead 1996). This may seem clear, but authors debate over the degree to which these things must be displayed to characterize stereotypy (Mason 1991). For our purposes a movement must appear to be excessively

repetitious, meaning it is performed more often than necessary or normal. A pine marten was once described as having a stereotypic scent marking disorder. Normally a scent mark lasts for about two weeks in the elements, but one researcher was able to record an individual in a small cage who placed 46 scent marks in only 10 minutes (Hediger 1950). This is an excellent example of the repetitious nature of stereotypy.

Movement should be considered invariant only if the normal pattern of that movement shows more randomness. For example, if rocking is normal in adolescent primates, then it should only be considered invariant if the rocking is always performed in the same plane of motion, body position, and spatial location. Although Mason (1991) and other authors (Carlstead 1996, in particular) cite many examples of possible functions of stereotypies, especially as an environment or stress regulator. Stereotypies show no apparently observable goal; the performance of this movement does not result in an immediate reward for the animal. Note that stereotypy is not universally defined as abnormal (Mason 1991), although it is usually considered abnormal as stereotypic behavior is almost exclusively displayed in captive animals and absent from wild individuals (Lynch 1993). There is some speculation that possession of stereotypies may be a normal condition for captive animals (Mason 1991), but due to lack of evidence this is not the prevailing attitude.

#### Background on the Spectacled Bear

A group of spectacled bears residing at St. Louis Zoo was chosen to assess causal factors of stereotypy. Spectacled bears (*Tremarctos ornatus*) are the last living representatives of an older lineage of bears that diverged from other bear lineages between 10 and 15 million years ago. This separation occurred right after the lineage leading to

pandas diverged (Ward and Kynaston 1995). They have a shorter muzzle than other bears and are the only bears whose range straddles the equator (Lynch 1993). They exist in the remaining moist tropical forest, sometimes called “cloud forest” on the slopes of the Andes mountains from eastern Panama to northern Argentina (Ward and Kynaston 1995). They are almost entirely herbivorous; fifty percent of their diet consisting of bromeliads (like pineapples). The five percent of their diet consisting of meat is from mice, rabbits, deer, and calves. Captive bears fare best on a diet of plant material (Peyton 1980). They are excellent climbers and have been seen foraging as high as 49 feet off the ground (Lynch 1993), where they have been known to stay in a single tree for up to four days to take advantage of ripe fruit (Ward and Kynaston 1995). In captivity they live between 20 and 25 years or at most up to 36 years. They are easy to identify as they possess light brown circular markings around their eyes, thus the common name, which vary in color and extensiveness in the individual. Males weigh about 250 lbs. and females are about 30% smaller (Ward and Kynaston 1995).

Unfortunately, spectacled bears are not the best subjects on which to perform a behavioral study. When assessing behavior, and assuming it is abnormal, it is often useful to compare it to the species’ normal wild behavior. This species’ natural habitat is the cloud forests which makes behavioral studies difficult because radio telemetry is not possible due to the mountains and heavy cloud cover. Also, their geographical location deters field research due to the political and environmental dangers inherent in the region (Lynch 1993). Exotic diseases and the prevalence of drug traffickers deter North American and European researchers. Because of this, almost all behavioral research on spectacled bears has been done in zoos (Ward and Kynaston 1995). The little information

obtained on these animals in the wild will be used to assess the abnormality of any stereotypic behavior.

The most significant research on spectacled bears was published in 1980 by Peyton. The research focused on habitat use, distribution, and food habits of the species. Although very little behavioral data were collected, some important behavioral characteristics were discovered in his field observations. He confirmed the low percentage of animal material in the bear's diet (about 4.1 % of scat volume). Although he never observed hunting bears, he gathered interesting stories on the hunting of spectacled bears. While in South America he was called to examine 14 cattle deaths blamed on spectacled bears. He found that 9 were the result of puma, rather than bear, attacks. Native people tell stories of the bears chasing cattle and other prey down steep hills or off cliffs to make the prey fall to the ground before they kill them. Other stories described the bear as twisting a cow's head to make it fall. Due to the exaggerated nature of the stories, scat analysis, and evidence on the carcasses, Peyton concluded that the bears are probably mostly carrion eaters, with a few large males being principally responsible for predation on cattle. He was also able to record some data on daily activity. He found no evidence of nighttime feeding. Individuals living in the forest were active throughout the day, while those living in the desert slept through the midday heat in caves.

#### Objectives of this Research

With the definition of stereotypy in mind, it is then important to conjecture why captive animals still perform stereotypic behavior despite vast improvements in pen conditions. There are as many causes for stereotypies in literature as there are articles written on stereotypic behavior. As far back as 1950, Hediger cited cage size and pen

conditions (“poor welfare”) exclusively as the cause of stereotypic behavior. He performed several experiments in which he was able to eliminate stereotypes by increasing the pen size of zoo animals. However, other factors have been proven to contribute to stereotypy performance. My purpose, then, is to examine how much social and environmental factors contribute to the stereotypic movement performed by one captive spectacled bear subject. The influence of factors such as social interaction, weather conditions, feeds and feeding schedule, cage design, and childhood experience on stereotypic behavior will be assessed. These factors may contribute more to this behavior than do factors such as age, sex, animal size, pen size, and health.

## MATERIALS AND METHODS

### Subjects

The St. Louis Zoo group of spectacled bears was chosen for several reasons. It represented an accessible social group of at least three, but no more than five individuals. Detailed observation would not have been possible with a larger group. The individuals were easily discernible after some initial observations. The “spectacle” markings of the eyes, as well as the markings on the nose and chest, and size made the three individuals visibly distinguishable. One of the individuals showed abnormal stereotypic behavior, but the others did not, implying at least in some part that cage conditions were not the main cause of this stereotypy.

Subject 1 (“Marie”) was a female, weighing about 130 lbs. She was born at St. Louis Zoo in 1990. She was loaned to another zoo where she successfully gave birth to a litter of cubs, but she has since been returned. During the study, she was implanted with a birth control measure. Zoo keepers did not know the chemical composition or name of the device, and hospital personnel were unavailable to yield this information. In addition to her smaller size, her “spectacles” are nearly complete large circles around her eyes. Subject 2 (“Sombra”) was a five-year-old male who performed stereotypic pacing behavior and excessively groomed his genitalia, which can also be classified as stereotypic. He was born in 1993 at the San Diego Zoo, where his pacing was initially observed by zoo officials. He was moved to St. Louis in 1995, where at the time of study weighed approximately 200

lbs. and was in good physical health. One of his litter mates from San Diego, Subject 3 (“Quixote”) was moved and housed with him. Subject 3 was five-years-old, in good health, and comparable in size to his brother. The only observable difference between the brothers was the pattern of light brown markings on their muzzles.

All three bears were kept in the same unique enclosure at the St. Louis Zoo. The bear grottos at this zoo were constructed from casts of limestone cliffs. The result was a rocky pen with numerous cliffs on the back wall and in the pen. Unfortunately, the builders failed to account for the spectacled bears’ climbing abilities and the bears climbed these cliffs to escape once. Electrical wiring was then installed around the top periphery of the pen to prevent this in the future. The pen in this study was approximately 60 feet wide and 40 feet deep (not including the ditch at the front). It contained a wooden log cemented upright and several stone ledges for the bears to climb and rest upon. There were also two hollow logs cut in half on the floor of the pen and chained to the upright log. A small waterfall against the back wall provided running water to a small pool in the center of the pen. At the front of the pen is a ten foot wide ditch which the bears can access by wide stone steps on either side of the cage. Because of the ditch and the fence restricting zoo visitors, the bears were at least 15 feet from visitors at all times. Trees and other plants were situated around the top of their enclosure providing some shade and protection from the elements. The bears were not able to reach these plants. The bears were observed watching the zoo visitors and seemed accustom to their presence. At no time during this study did any zoo visitors throw anything into the pen.

## Ethogram Construction and Use

Initial observations enabled me to learn how to identify each bear and to create an ethogram, which was used in all data collection. Thirteen behavior categories were identified and defined based on their usefulness in this research. The ethogram categories were as follows:

- sleeping-- lying down with no noticeable activity, also included resting states with the bear in a horizontal position;
- eating-- placing items in the mouth, chewing and swallowing at least some of the item;
- pacing-- the stereotypic circular, figure eight or linear walking around the pen associated with a repeated tossing of the head;
- drinking-- the ingestion of a liquid;
- grooming-- the biting, licking, or sucking of the integument, but in not the genital region;
- grooming genitals-- the biting, licking, or sucking of the genitals;
- interactions-- social behavior of any sort, in the following three categories:
  - ⇒ friendly (with no use of teeth; sometimes included mutual grooming or just touching),
  - ⇒ aggressive (use of the teeth and/or claws on pen mate with intent to harm or force them out of an area), or
  - ⇒ moderate (any other social interaction with moderate use of the teeth and claws, such as playing);
- swimming-- the body mostly submerged in water;

- walking-- locomotion of any type except while submerged in water or any stereotypic movements;
- laying-- remained still while in a horizontal body position;
- sitting-- remained still with forelegs straight and hind legs bent with the rump on the ground or hind legs straight out in front of body and body vertical with rump on the ground;
- standing-- remained still and upright either quadrupedally or bipedally.
- not visible in enclosure-- animal could not be seen in upper portion of pen due to raised features in the pen or the tunnels leading to the inner pen, also included when the animal was inside (there was no public observation area inside the bears' inner pen);
- not visible in ditch-- animal could not be seen due to being in the large ditch at the front of pen;

### Data Collection

Data collection occurred from June to November 1998. Much of the data collection methods and charts were elicited from Crockett (1996). Scan sampling data was taken every 20 seconds when a behavior was recorded for each individual, even if they were not visible. Table 1 is a sample scan data collection table. The pen was scanned from left to right and the first behavioral state observed for each individual was recorded. Continuous data were taken by recording an initial behavior state for each individual, and when the behavior state changed for any individual, the time of change and the new behavioral state were recorded. Table 2 is a sample of a continuous data collection table.

Table 1. Scan Data Collection Form: Sample Portion

Scan data

Spectacled Bears

Date:

Weather:

| Start Time: | Subject<br>1 | Subject<br>2 | Subject<br>3 | Pacing Duration | # of<br>viewers | Comments |
|-------------|--------------|--------------|--------------|-----------------|-----------------|----------|
| 00:00:20    |              |              |              |                 |                 |          |
| 00:00:40    |              |              |              |                 |                 |          |
| 00:01:00    |              |              |              |                 |                 |          |
| 00:01:20    |              |              |              |                 |                 |          |
| 00:01:40    |              |              |              |                 |                 |          |
| 00:02:00    |              |              |              |                 |                 |          |
| 00:02:20    |              |              |              |                 |                 |          |
| 00:02:40    |              |              |              |                 |                 |          |
| 00:03:00    |              |              |              |                 |                 |          |
| 00:03:20    |              |              |              |                 |                 |          |
| 00:03:40    |              |              |              |                 |                 |          |
| 00:04:00    |              |              |              |                 |                 |          |

Table 2. Continuous Data Collection Form: Sample Portion

Continuous data

Spectacled Bears

Date:

Weather:

Time:

| Subject<br>1 | SD | Subject<br>2 | SD | Subject<br>3 | SD | Comments |
|--------------|----|--------------|----|--------------|----|----------|
|              |    |              |    |              |    |          |
|              |    |              |    |              |    |          |
|              |    |              |    |              |    |          |
|              |    |              |    |              |    |          |
|              |    |              |    |              |    |          |
|              |    |              |    |              |    |          |

A schedule for bear observation at the zoo was set up as follows: observation began at 1000 hrs, when 1 - 1.5 hrs of scan sampling occurred. The bears usually were not released from their inner enclosure until 1000 hrs; prior to this they are fed the fruit and vegetable part of their diet in their inside pen. The amount of time spent observing the bears was determined by weather conditions and the amount of bear activity. Observation ceased for the next 1 - 1.5 hrs and resumed at 1230 hrs. Two hours of continuous data were recorded. At 1430 hrs, observation ceased for a half hour. At 1500 hrs, 20 minutes of continuous data were taken and, at 1520 hrs scan data were collected until 1700 hrs when observation ceased due to the zoo closing. During this period around 1600 hrs, there was a public feeding in which the bears receive one or two fish. At approximately 1630 hrs the bears inner pen is opened for the evening and they were fed an "omnivore" diet, which they had access to for the rest of the evening.

The bears were observed on 10 separate occasions. It was very important that those days/ocassions represented different weather conditions and temperature ranges. Therefore, observation began in June and continued into November so that an appropriate range of temperatures could be represented. In addition to observational sampling records, journal entries were made recording the days events in a qualitative way, including any unusual behaviors observed, patterns noticed, and events not recorded by the quantitative methods above. Following pen improvements, I returned to the zoo in April 1999 for an observation day to note any changes.

### Data Analysis

The daily observation schedule was split into eight time periods to aid in data interpretation. Details on the beginning and ending times plus lengths of these time periods

are shown in Table 3. Time period 1 consisted of any significant observation prior to 1000 hrs. It may be important to note that this is immediately after their morning feeding. Time period 2 was the main morning observation consisting of observation between 1000 hrs and 1100 hrs. Any observation after 1100 hrs was put into time period 3. The continuous data taken from 1230 hrs to 1430 hrs are in time period 4. This period was usually the bears' least active period of the day. The continuous data taken from 1500 to 1520 hrs was placed in time period 5. Observation from 1520 to 1600 hrs was time period 6. From 1600 to 1620 was time period 7; this included the public feeding of fish. From 1620 to 1700 hrs was time period 8; this included when their inner pen became accessible to the bears as well as when they were fed their "omnivore" diet. Despite the time periods being of unequal length, the data from each will be comparable. The data generated were percentages indicating the rate of stereotypic behavior over a certain time period, not a length of time spent performing such behavior.

Scan data were analyzed with the aid of computer software (SPSS), so percentages of each time period spent in each behavioral state could be easily calculated. Continuous sampling had to be analyzed by hand to generate the same percentages. For each day it was also necessary to calculate the percentage of each day spent in each behavioral state. To accomplish this the approximate number of minutes of each time period in a certain state was calculated (In the case of scan sampling these are only estimates of the trends observed every twenty seconds; the actual percentage of each time period performing a certain behavior was not directly measurable). The number of minutes each day was summed in each behavior category. This was then used to calculate the percent of each day spent in each behavior category. When all ten days were finished, it

Table 3. Data Collection Time Period Variation

| Time Period | No. of Instances | Beginning Times |          |          | Ending Times |          |          | Length (in minutes) |        |         |
|-------------|------------------|-----------------|----------|----------|--------------|----------|----------|---------------------|--------|---------|
|             |                  | Earliest        | Latest   | Average  | Earliest     | Latest   | Average  | Short               | Long   | Average |
| 1           | 5                | 09:30:00        | 09:43:00 | 09:36:48 | 09:57:20     | 10:01:00 | 09:59:40 | 14:20               | 30:00  | 22:52   |
| 2           | 9                | 09:50:00        | 10:20:00 | 10:00:00 | 10:41:00     | 11:00:00 | 10:54:27 | 40:00               | 60:00  | 54:27   |
| 3           | 4                | 10:54:00        | 11:00:00 | 10:58:30 | 11:14:00     | 11:40:00 | 11:23:30 | 20:00               | 40:00  | 25:00   |
| 4           | 10               | 12:25:00        | 12:45:00 | 12:31:00 | 02:30:00     | 02:45:00 | 02:31:30 | 120:00              | 125:00 | 120:30  |
| 5           | 10               | 03:00:00        | 03:03:00 | 03:00:18 | 03:20:00     | 03:20:00 | 03:20:00 | 17:00               | 20:00  | 19:42   |
| 6           | 10               | 03:20:00        | 03:20:00 | 03:20:00 | 04:00:00     | 04:00:00 | 04:00:00 | 40:00               | 40:00  | 40:00   |
| 7           | 10               | 04:00:00        | 04:00:00 | 04:00:00 | 04:20:00     | 04:20:00 | 04:20:00 | 20:00               | 20:00  | 20:00   |
| 8           | 10               | 04:20:00        | 04:20:00 | 04:20:00 | 04:40:00     | 05:00:00 | 04:58:00 | 20:00               | 40:00  | 38:00   |

was then possible to determine the average (arithmetic mean) for each behavior category for each bear. For Subject 2 the averages (arithmetic means) were determined in each time period for certain behaviors (pacing, grooming, grooming genitals, and sleeping). All weather data were determined from charts and data available to the public through the National Climatic Data Center web site ([www.ncdc.noaa.gov](http://www.ncdc.noaa.gov)).

## RESULTS

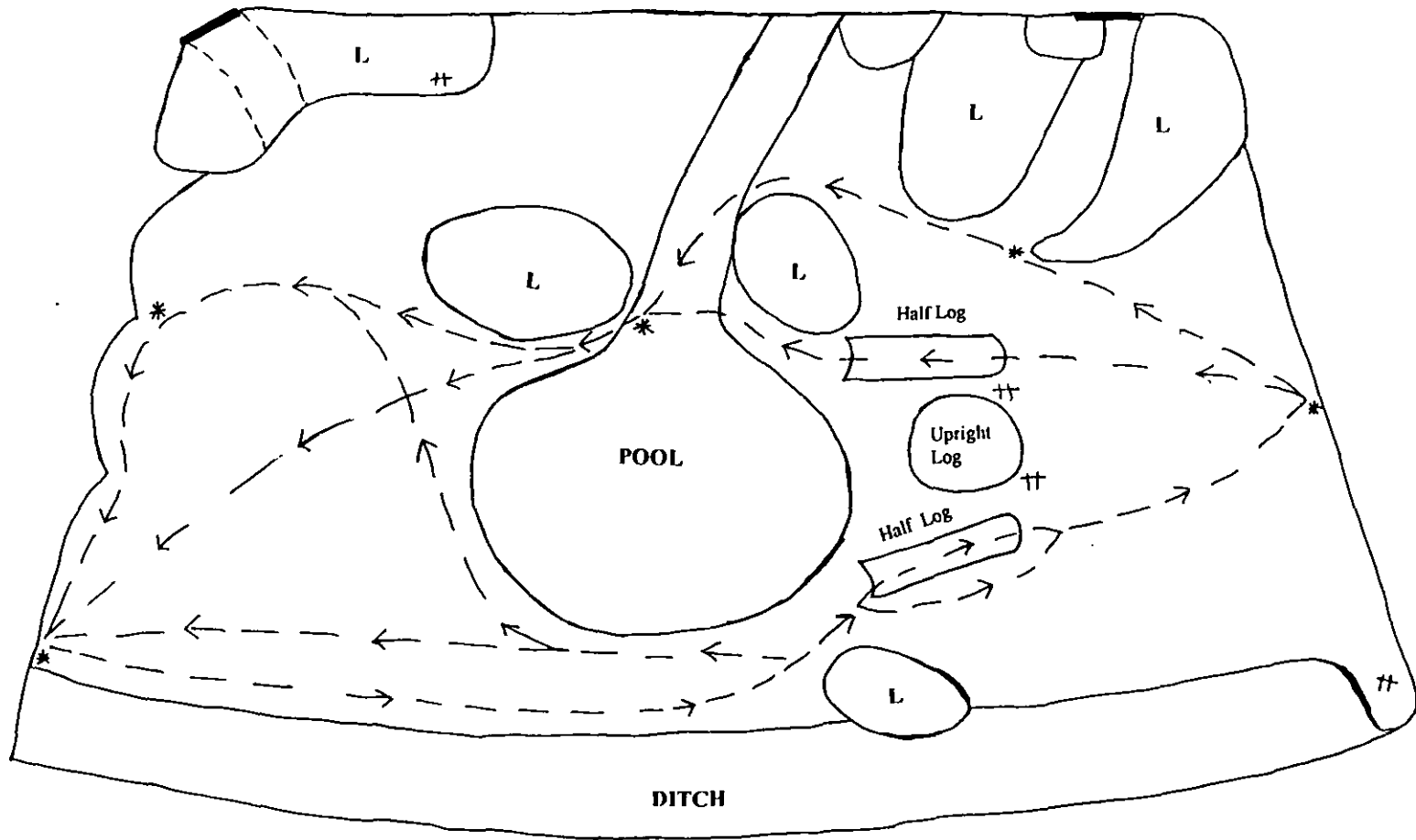
### Interviews with Zoo Keepers

One of the most important aspects of my research was the information I gained in interviews with the bears' keepers. Their intimate knowledge of the bears' health, behavior, and background was of vital importance. During the interview I discovered several important facts. Subject 2 had been performing both stereotypic behaviors (pacing and grooming genitalia) at San Diego prior to arriving at St. Louis in 1995. Subject 3 had also been known to perform some pacing, although it was a rare occurrence and was not observed at any time during my research. Basically, Subject 3 was considered "normal." All three bears were mother-raised. One keeper described the bears as unadjusted to humans and especially pointed out that Subject 2 was "more nervous" than the others.

### Characteristics of the Observed Stereotypy

Initially it was important to determine several characteristics about Subject 2's stereotypies. Figure 1 shows all of the paths that the bear used in his stereotypic pacing. They were somewhat varied, but on all paths there are areas where the bear raised his short nose skyward and then rapidly lowered his head. These occurrences were called head tossing. The pacing was done in a trance-like state, but he seemed capable of breaking this trance. This characteristic is similar to the observations on polar bears (*Ursus maritimus*); research on this species concluded that bears were often interrupted during stereotypic bouts, indicating no reduced state of arousal (Wechsler 1991).

Figure 1. Diagram of Pen with Pacing Paths



- -> Pacing Paths (directional arrows)
- \* Locations where head tossing occurred
- ++ Locations where Grooming Genitals occurred
- ▬ Doors to inner pen
- L Ledges

Due to the variance in paths, Subject 2's motions were difficult to quantify. Variance has been noticed in polar bears, where 5% of their stereotypic pacing bouts deviated from a normal path due to shifting a turning point, avoiding a cage mate, or more often for no apparent reason (Wechsler 1991). Subject 2's paths deviated more frequently, but the reasons for deviation were the same. In fact I did not recognize as "pacing" any other paths besides the ones back and forth across the front of the pen until August 5. Therefore, percentage of time spent pacing on the days before this may appear low only do to a failure of the observer. Figure 1 also shows some of the common places where Subject 2 groomed his genitals, although this occurred throughout the pen.

Tables 4 through 6 show how Subject 2's activities compare to the other bears. These charts revealed that it may be important to consider grooming to be an abnormal behavior as well. Subject 2 spent about 2% more of his daily time grooming than the others. Tables 4 through 6 reveal that Subject 2 slept more than Subject 1 or 3 (32.8% versus 27.5% and 31.0% respectively). This is different than what Wechsler (1991) noticed. He showed that the most active bears, those that slept the least in a day, performed the most stereotypic behavior (1991). It is worth noting, there were definite differences in the amount of sleeping by Subject 2 from one period to the other, as shown in Table 5. Table 7 accounts for these differences by removing the average amount of time spent sleeping from the average length of each period. The remaining time can be considered "active" time. Table 7 indicates the percentage of this remaining time that the bear spent pacing, grooming and grooming genitals in each period.

It is important to realize that there were differences between all three subjects concerning most of the behavior categories. These differences were expected. Each

Table 4. Average Daily Time-Budget of All Behavior for Subject 1

| Behavioral State         | Percentage of Daily Budget |
|--------------------------|----------------------------|
| Sleeping                 | 27.5%                      |
| Not Visible in Enclosure | 11.2%                      |
| Not Visible in Ditch     | 8.6%                       |
| Eating                   | 11.0%                      |
| Stereotypic Pacing       | 0.0%                       |
| Drinking                 | 0.2%                       |
| Grooming                 | 1.0%                       |
| Grooming Genitalia       | 0.0%                       |
| Interaction - Friendly   | 0.2%                       |
| Interaction - Aggressive | 0.1%                       |
| Interaction - Moderate   | 0.1%                       |
| Swimming                 | 0.4%                       |
| Walking                  | 17.5%                      |
| Laying                   | 7.7%                       |
| Sitting                  | 7.8%                       |
| Standing                 | 6.6%                       |

Table 5. Average Daily Time-Budget of All Behavior for Subject 2 (Including average percent of time spent in each period sleeping, pacing, grooming, and grooming genitals)

| Behavioral State         | Time Periods |       |       |       |       |       |       |       | % of Daily Budget |
|--------------------------|--------------|-------|-------|-------|-------|-------|-------|-------|-------------------|
|                          | 1            | 2     | 3     | 4     | 5     | 6     | 7     | 8     |                   |
| Sleeping                 | 19.7%        | 24.4% | 32.9% | 50.3% | 51.4% | 31.7% | 5.7%  | 5.6%  | 32.8%             |
| Not Visible in Enclosure |              |       |       |       |       |       |       |       | 12.2%             |
| Not Visible in Ditch     |              |       |       |       |       |       |       |       | 11.0%             |
| Eating                   |              |       |       |       |       |       |       |       | 3.1%              |
| Stereotypic Pacing       | 13.4%        | 9.6%  | 6.6%  | 5.0%  | 0.0%  | 0.4%  | 0.2%  | 0.2%  | 4.4%              |
| Drinking                 |              |       |       |       |       |       |       |       | 0.6%              |
| Grooming                 | 0.0%         | 0.6%  | 0.0%  | 5.1%  | 3.7%  | 0.7%  | 0.8%  | 3.5%  | 3.2%              |
| Grooming Genitalia       | 5.1%         | 4.6%  | 8.3%  | 6.0%  | 3.6%  | 11.1% | 19.0% | 13.2% | 8.0%              |
| Interaction - Friendly   |              |       |       |       |       |       |       |       | 0.2%              |
| Interaction - Aggressive |              |       |       |       |       |       |       |       | 0.1%              |
| Interaction - Moderate   |              |       |       |       |       |       |       |       | 0.4%              |
| Swimming                 |              |       |       |       |       |       |       |       | 3.4%              |
| Walking                  |              |       |       |       |       |       |       |       | 7.5%              |
| Laying                   |              |       |       |       |       |       |       |       | 5.2%              |
| Sitting                  |              |       |       |       |       |       |       |       | 5.5%              |
| Standing                 |              |       |       |       |       |       |       |       | 2.2%              |

Table 6. Average Daily Time-Budget of All Behavior for Subject 3

| Behavioral State         | Percentage of Daily Budget |
|--------------------------|----------------------------|
| Sleeping                 | 31.0%                      |
| Not Visible in Enclosure | 12.5%                      |
| Not Visible in Ditch     | 27.2%                      |
| Eating                   | 2.1%                       |
| Stereotypic Pacing       | 0.0%                       |
| Drinking                 | 0.2%                       |
| Grooming                 | 1.3%                       |
| Grooming Genitalia       | 0.2%                       |
| Interaction - Friendly   | 0.3%                       |
| Interaction - Aggressive | 0.1%                       |
| Interaction - Moderate   | 0.4%                       |
| Swimming                 | 3.1%                       |
| Walking                  | 8.3%                       |
| Laying                   | 5.4%                       |
| Sitting                  | 5.6%                       |
| Standing                 | 2.2%                       |

Table 7. Percent of Active\* Time in Each Period Spent Pacing, Grooming, and Grooming Genitalia (accounts for different rates sleeping)

| Behavioral State   | Time Periods |       |       |       |      |       |       |       |
|--------------------|--------------|-------|-------|-------|------|-------|-------|-------|
|                    | 1            | 2     | 3     | 4     | 5    | 6     | 7     | 8     |
| Stereotypic Pacing | 16.7%        | 12.7% | 9.8%  | 10.1% | 0.0% | 0.6%  | 0.2%  | 0.2%  |
| Grooming           | 0.0%         | 0.8%  | 0.0%  | 10.3% | 7.6% | 1.0%  | 0.8%  | 3.7%  |
| Grooming Genitalia | 6.4%         | 6.1%  | 12.4% | 12.1% | 7.4% | 16.3% | 20.1% | 14.0% |

\*Active time does not include the average amount of time spent sleeping in each period.

individual animal had certain activities they were more occupied with than others. These differences were simply due to individual uniqueness. Subtle differences should not be confused with the high occurrences of abnormal behaviors in the case of Subject 2. For example, all three bears spent time grooming and Subject 3 was even recorded grooming his genitalia, but the rates of these activities are normal in Subjects 1 and 3 (1.0% grooming and 0% grooming genitalia in Subject 1 and 1.3% and 0.2% in Subject 3) and clearly abnormally high in subject 2 (3.2% grooming and 8.0% grooming genitals).

#### Feeds and Feeding Schedule

One factor often cited as a cause of stereotypic movement is the urge to hunt or forage. Captive environments where food is provided on a scheduled basis do not permit the animal to spend as much time in these activities as they would in the wild. These urges can result in stereotypic behavior which increases prior to feeding periods, especially pacing behavior (Carlstead 1996). It was therefore important to determine if Subject 2 showed increased stereotypic behavior around feeding times. Figure 2 shows the average (arithmetic mean) that Subject 2 spent pacing, grooming, and grooming genitals during each of the 8 time periods. Pacing does not increase in relation to the afternoon feeding sessions, although grooming genitals does. Grooming does not appear to be time related at all. Pacing seems most prevalent in the morning immediately after the bears are fed their fruits and vegetables and released into the outdoor pen. However, Table 3 shows that the morning sessions were not observed as often as the afternoon sessions, so it is possible that the morning time periods (1-3) are bias. Also important in interpreting the importance of feeding schedule is Table 7 which corrects for the differences in amount of time spent

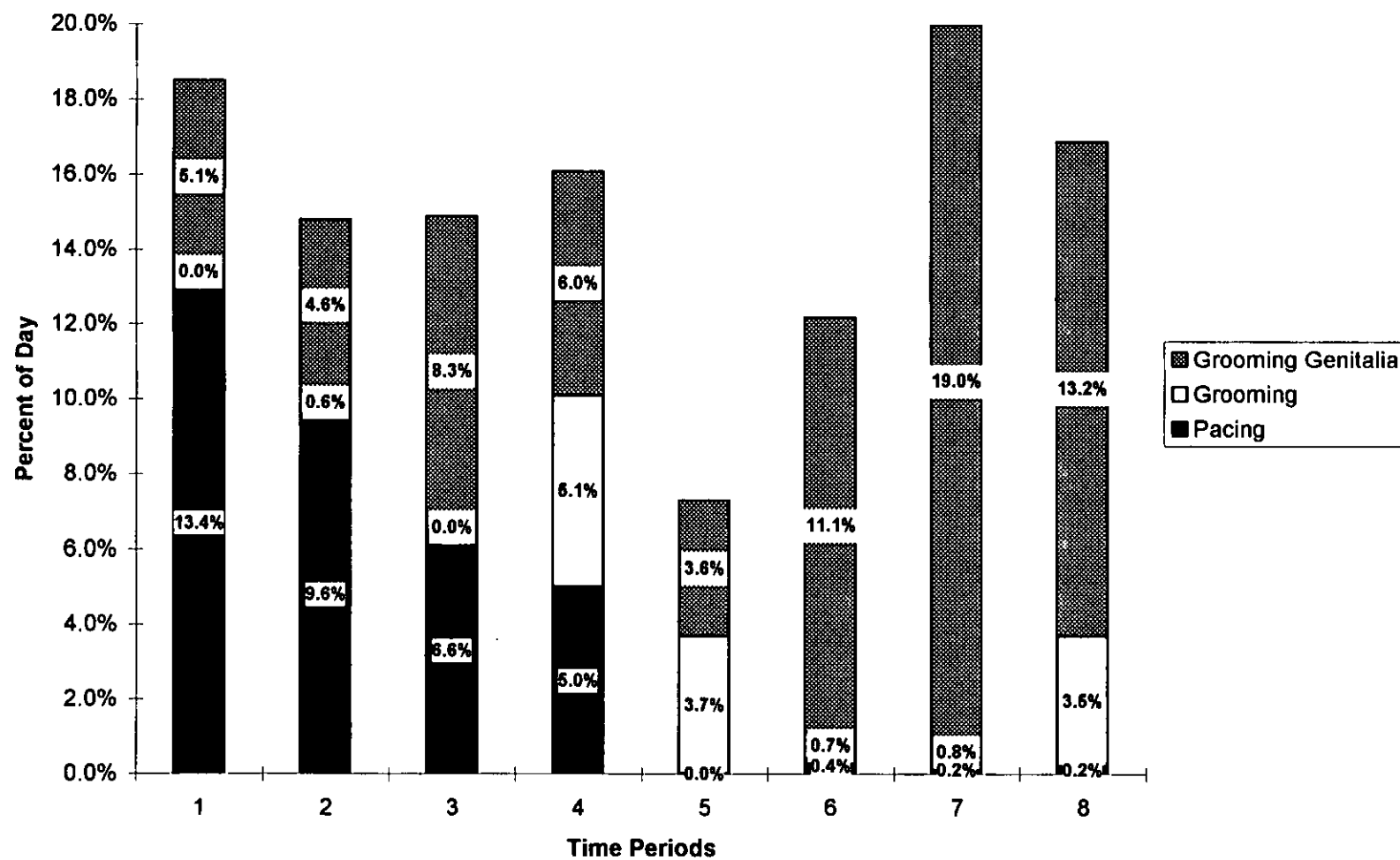


Figure 2. Average Percent of Time in Each Period Spent Pacing, Grooming, and Grooming Genitals by Subject 2

sleeping between the periods. This table fails to show any increases in either stereotypy associated with feeding.

Grooming genitals is a suckling stereotypy, which is not usually associated with feeding schedules. Suckling is often considered a coping response to abnormally high levels of stimuli that creates a rhythmic pattern of movement and is often associated with the comfort usually provided by the animal's mother (Mason 1991). In this case feeding methods such as schedule, types of feed, and presentation method, may be creating high levels of stimulus. However, the actual stereotypy was caused not by the feeding, but by some childhood occurrence, as is often observed in primates (Mitchell et al. 1979).

Hediger (1950) was one of the first animal behaviorist to study and treat stereotypies. He claimed that stereotypies were a sure sign of poor welfare including such things as inadequate space, poor flooring, and improper feeds. The St. Louis Zoo fed its spectacled bears with an omnivore diet very low in animal protein content. They fed the bears 3 times a day, which Carlstead et al. (1991) recommends to reduce the rate of stereotypy in captive bears. Additionally, the bears were occasionally fed unusual things. Did these unusual feeds cause an increase or decrease in any stereotypic movement or did the novel stimulus in fact decrease stereotypy? Other experiments in behavioral enrichment have shown that feeding methods that encourage foraging reduce stereotypy in bears that show increased stereotypic movement around feeding times (Carlstead et al. 1991). On June 24, 1998, a keeper threw three blocks of ice with fruit frozen in them into the bears pool during time period 4. Subject 2 did not pace during this time period and spent 0.7% and 3.1% of this period grooming and grooming genitalia, respectively. These were much lower than the averages of 5.0% pacing, 5.1% grooming, and 6.0% grooming

genitalia for time period 4 (see Table 5). He also spent a below average amount of time grooming, grooming genitalia, and pacing on this day. On July 26, 1998, the bears were given large bones with some meat on them which they had access to all day. Pacing and grooming genitals were above average on this day, while grooming was below average. The same types of bones were present on October 25, 1998, and pacing and grooming were below average and grooming genitalia was very high. These data seems to indicate that, at least in some part, complicating feeding methods involving fruit, but not meat, reduce the occurrence of stereotypy in subject 2.

#### Assess the Effect of Weather Conditions

In order to assess if weather conditions affected the bears Figures 3, 4, and 5 were constructed. Figures 3, 4, and 5 are graphs of percent of the day spent pacing and grooming genitalia versus temperature or inches of precipitation. Figures 3 and 4 clearly show that there is no relation between temperature and the performance of stereotypies. The idea being explored was that the physiological stress of being forced to live in abnormal or unnatural temperatures would translate into psychological stress and cause higher rate of stereotypy performance. The precipitation graph (Figure 5) shows a more direct relation. Days of higher precipitation definitely show a higher degree of stereotypic pacing performance. However, I do not think that enough observation occurred during precipitation to conclude that one directly affects the other.

More important are other implications of Figure 5. On rainy days there are typically far fewer viewers at the zoo than on days lacking precipitation. This figure may indicate that the number of viewers, if we can assume that there are less on rainy days, is

Figure 3. Percent of Day Spent Pacing vs. Temperature

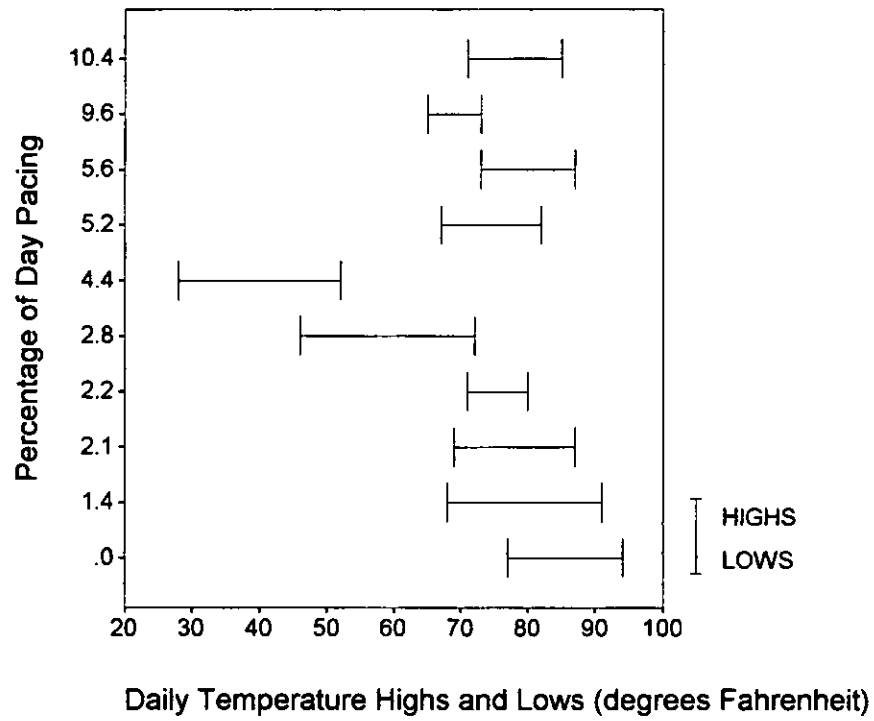


Figure 4. Percent of Day Spent Grooming Genitals vs. Temperature

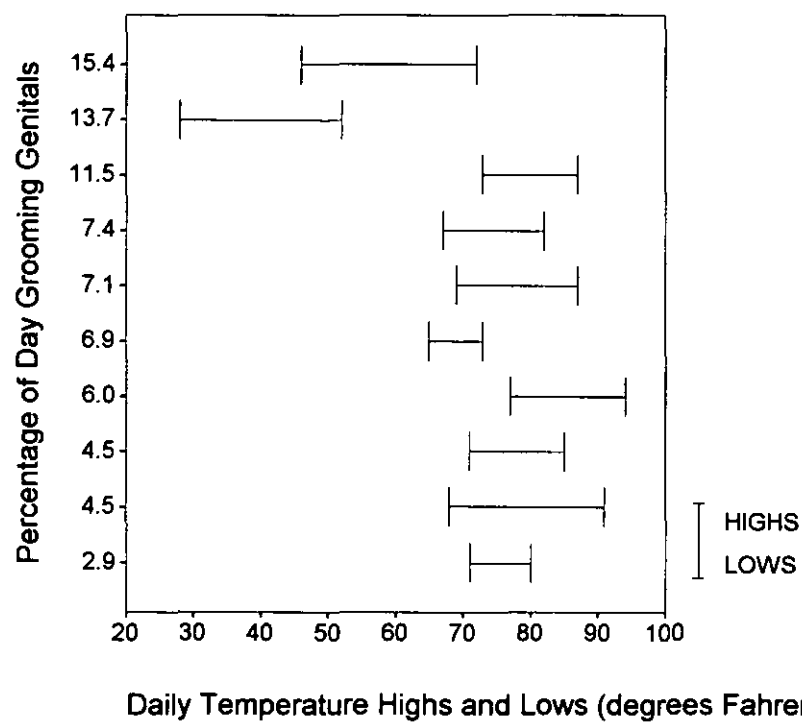
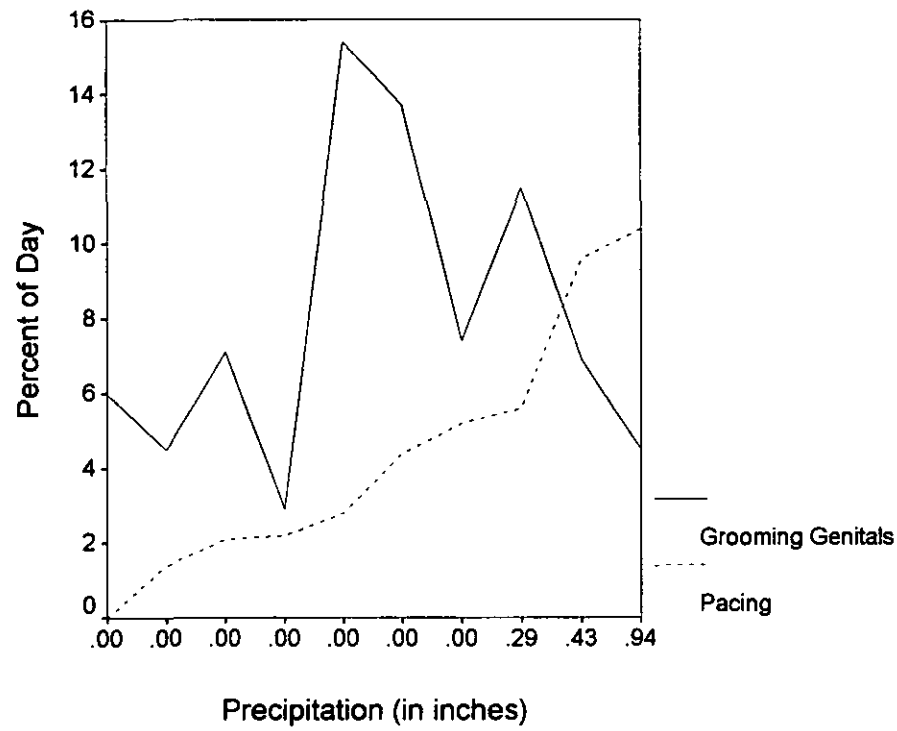


Figure 5. Percent of Day Spent Pacing and Grooming Genitals vs. Amount of Precipitation



inversely proportional to an increased stereotypic rate. This is a rather unexpected outcome; perhaps the viewers provide an interesting stimulus to the bear.

#### Effect of Other Physical Factors

There are several additional physical factors that must be considered. In certain animals stereotypic behavior may increase with age (Heid and Deesing 1998). If this were the case with these animals, Subject 1, who is three years older than Subjects 2 and 3, had a greater chance of performing stereotypic behavior. However, there is no evidence that this is the case. Size of the animal, especially in relation to cage size, is another factor. In this case Subjects 2 and 3 were approximately the same size. If animal size was the main factor then Subject 3 would show amounts of stereotypy similar to that of Subject 2. Pen or cage size has been the most often blamed factor in stereotypies. All three bears are housed in the same size pen and only one showed significant stereotypic movement. Perhaps the real problem was not the amount of space, but the quality of the space provided (Carlstead 1996). Another important factor to consider is the sex of the animal. There is no evidence to suggest that one sex shows more stereotypy than another (Marriner and Drickamer 1998). One part of this though may be due to sexual frustration. Both of the males were five years old and neither has ever mated. (Subject 1's birth control implant made her unresponsive to the males.) Urge to reach a potential mate has been documented as a cause for stereotypic behavior (Hediger 1950). Could this also be the case if the mate is physically accessible, but unresponsive to advances?

#### Analysis of Social Interactions

One factor I wished to consider was Subject 2's social skills. Table 8 shows information regarding social interactions between all three subjects. Subject 2 does not

Table 8. Comparing Social Interactions Between Subjects 1, 2, and 3

|                        | Subject 1    |               | Subject 2    |               | Subject 3    |               |
|------------------------|--------------|---------------|--------------|---------------|--------------|---------------|
|                        | No. Involved | No. Initiated | No. Involved | No. Initiated | No. Involved | No. Initiated |
| Aggressive Interaction | 3 to 5       | 0             | 10 to 12     | 3 to 4        | 9            | 3             |
| Moderate Interaction   | 6            | 1             | 27 to 28     | 2             | 26 to 27     | 4             |
| Friendly Interaction   | 14           | 2             | 19           | 1             | 24           | 9             |

|                        | Between 1 & 2 | Between 2 & 3 | Between 3 & 1 |
|------------------------|---------------|---------------|---------------|
| Aggressive Interaction | 2 to 4        | 8             | 1             |
| Moderate Interaction   | 4             | 23 to 24      | 5             |
| Friendly Interaction   | 5             | 14            | 10            |

seem particularly abnormal according to these data. He seemed to initiate a larger percentage of aggressive interactions, but I did not always record which individual initiated the interactions. Subject 2 seemed to have more interactions than Subject 1 and less than Subject 3. Subject 2 had more aggressive interactions with the female, Subject 1, and less friendly interactions with her than his brother, Subject 3. In general the brothers interacted more together than with the female. There may, in fact, be many implications for these differences. Figure 6 also shows that there was no evidence to suggest that interactions are higher or lower on days when increased stereotypic rate was noted.

#### Individual Sensitivity and Childhood Trauma

Finally the last factor to explore was individual susceptibility to stereotypic behavior. Several factors can contribute to this, including several which were beyond the scope of this study. These would include genetics, early childhood traumas, relationship with mother, and psychological disorders. The keeper described Subject 2 as more nervous, but that could be due to any of the above factors. There is evidence that a parent's different treatment of first born infants results in their performing more stereotypies than later born siblings (Mitchell et al. 1979). Could this also be the case in a litter of bear cubs where the mother shows preferential treatment to the strongest infant to increase her fitness? No record of the childhood events for the bears of this study was accessible.

Some authors believe that the stereotypies shown by animals may in fact be equivalent to human obsessive-compulsive disorder, autism, schizophrenia, mental retardation, and brain damage (Mason 1991). Mental retardation and brain damage could be tested medically, but those resources were beyond the scope of this study. The other

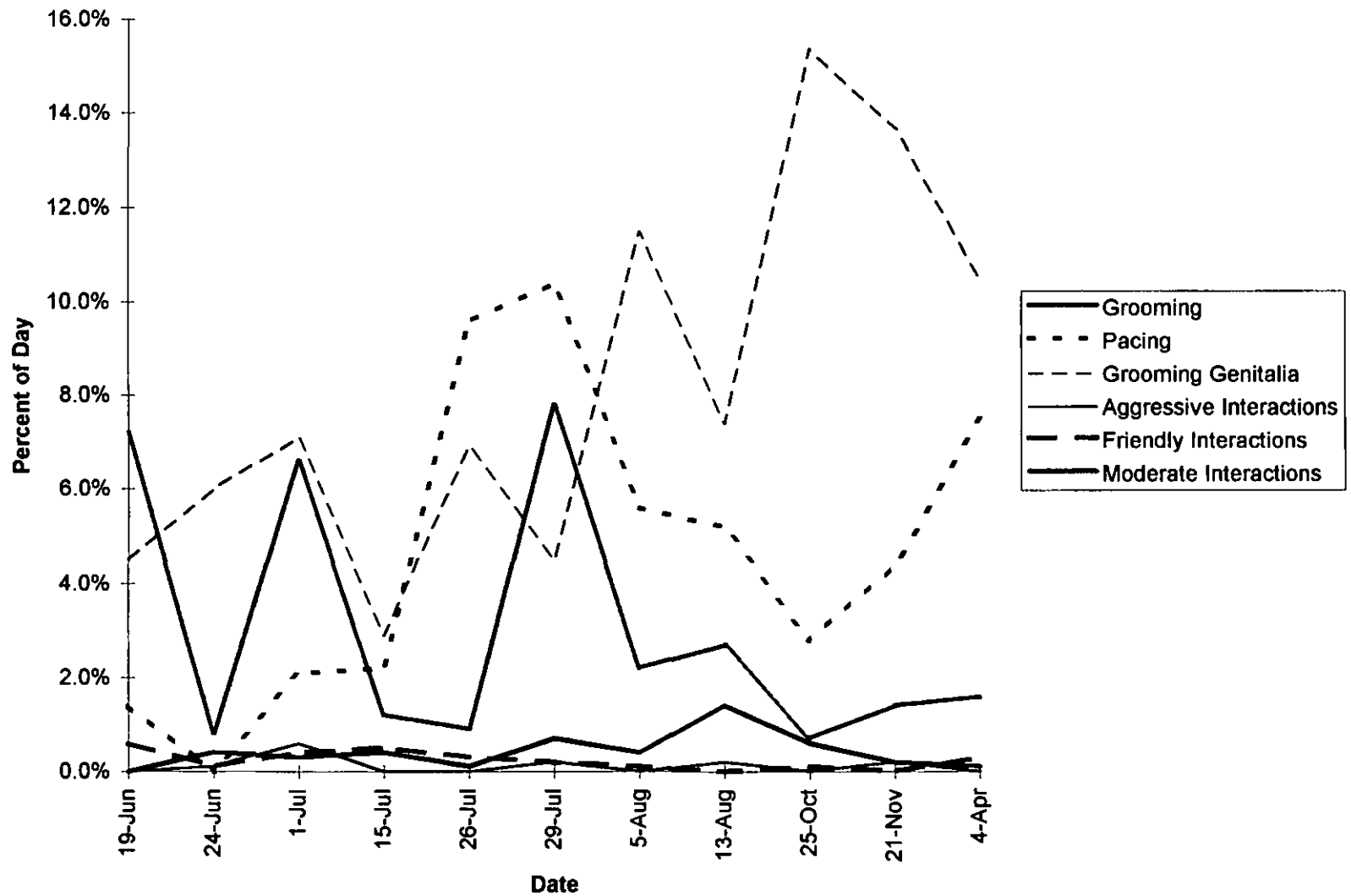


Figure 6. Chronological Progression of Percent of Day Spent in Social Interactions, Pacing, Grooming, and Grooming Genitals

disorders mentioned fall in to two categories: neuroses and psychoses. Autism and schizophrenia are psychoses, the category of more severe psychological disorders. They are typically characterized by interference with the sufferer's normal perception and orientation. The sufferer is incapacitated socially, and their behavior often causes injury to themselves or others (Lindzey et al. 1978). Subject 2 did not display these symptoms. While he may seem unusual socially, he is not incapacitated. He does not have problems with orientation or self injury. His symptoms seem much more closely related to a neuroses type disorder, such as obsessive compulsive. Individuals with neuroses may be socially impaired, but their main problem is anxiety (Lindzey et al. 1978). Anxiety is often associated with stereotypies (Mason 1991). The chief characteristics of obsessive compulsive disorder are that certain obsessions produce anxiety causing the sufferer to feel obligated to perform certain actions which they believe separate them from the source of their anxiety (Lindzey et al. 1978). Like stereotypies, obsessive compulsive arises from phobias and in some, but not all cases reduce the anxiety felt by the performer (Lindzey et al. 1978). While Subject 2 showed many symptoms of obsessive compulsive there was not enough evidence to diagnose him with this disorder, although it remained a possibility. Also important to consider is that attributing psychological disorders to these animals may be just anthropomorphizing too much.

A final day of observation occurred on April 4th, 1999. In March 1999 several aerial features were added to the cage. A hammock made of old fire hoses was suspended between a high cliff at the back of the cage and the tree in the center. Below the hammock half a hollow log was suspended between a lower portion of the same cliff and a lower part of the same tree. Also the female was taken off birth control. On April 4th, Subject 2

spent 7.5% of his day pacing, 1.6% grooming, and 10.5% grooming his genitals. These values are approximately the same as those in Table 5. This seems to indicate that the new aerial structures have not significantly added stimulation to the bear's environment. Mason (1991) suggested that there may be a period of adjustment after a new stimulus is added to an animal's cage during which stereotypy will increase dramatically to taper off to an lower rate than the initial rate prior to the addition of the stimulus. If this is the case, the bear's stereotypy may taper off in the future when he is fully adjusted to the new structures.

## DISCUSSION

We are left now with deciding which of the above mentioned factors are the most important in causing this bear's stereotypy. While grooming genitals and pacing should definitely be considered stereotypical and highly excessive, grooming may not be. Subject 2 may groom more than the others, but it fails to occur in any noticeable pattern and could be due to any number of other factors (dry skin, external parasites, rashes, etc.). There is not enough data to conclude that this behavior is stereotypic in nature.

### Most Important Physical Factors

We must now determine which physical factors play the most important role in the pacing and grooming genitals stereotypies. Subject 2 is the same size, sex, and age as his brother. If any of these were main factors, his brother, Subject 3, would also display high levels of stereotypic behavior. Although sex and size may contribute slightly to Subject 2's stereotypy, since Subject 3 also shows occasional stereotypic pacing, they are not the main cause. All three animals are also in excellent health, thus physical health is not a factor contributing to stereotypy in subject 2.

Another physical factor explored was pen size. Although increased pen size has been shown to eliminate stereotypy in some cases (Hediger 1950), it does not seem as important in this case. All three bears live in the same size cage, yet only one shows stereotypic movement. Cage size tends to be more important in animals who patrol large territories in the wild (Carlstead 1996), such as polar bears, whom patrol huge territories

to support their carnivorous diet. Spectacled bears, on the other hand, may define their territories by tree clusters, which are not particularly large areas (Lynch 1993). One problem in early cage designs was that the animal was not able to withdraw from threats (i.e., viewers, keepers, etc.) at least two flight distances and therefore underwent increased stress due to their proximity (Hediger 1950). Because the other two bears do not seem distressed, it is safe to conclude that the pen is of adequate size to allow the animals to adequately withdraw from threats.

#### Influence of Environmental Factors

I am inclined to agree with Carlstead (1996) who claimed that space is more important in quality than in quantity. Complicating an animals surroundings by adding objects has been shown to decrease stereotypy. The spectacled bear is a highly arboreal species and it may be important that their pen reflect this lifestyle. Perhaps a spectacled bear pen should be constructed in the same way a pen for a large, clumsy ape would be. Although they are not quite as agile as primates, I learned from one zoo official that the bears in this study were able to escape from their pen. They were returned with minimal difficulty and electrical wiring was installed around the top of the pen to prevent future incidence. This revealed how truly agile these bears can be. Although the other bears living in this pen may be normal, they too could benefit from a pen more suited to their arboreal tendencies. The current improvements are one step toward this ideal. Other structures encouraging climbing should be added to create a more challenging and complex aerial cage structure.

Another environmental factor I explored was the influence of weather. Although no correlation was found between temperature and stereotypy, there was one between

precipitation and stereotypy. I strongly suspect that this is again due to other environmental conditions. There is not much evidence, nor do I feel, that the amount of precipitation directly causes increased rates of stereotypy. Perhaps the greater number of viewers on days without precipitation provide a stimulus strong enough to divert the bears attention from stereotypic behavior. In this sense the rain is not the problem, but the lack of stimulus from the viewers is the cause.

#### Importance of Feeds and Feeding Schedule

There is some relationship between the bears feeding schedule and Subject 2's stereotypic behavior (see Figure 2). Pacing was most prevalent in the morning immediately after they receive the fruit and vegetable part of their diet. Grooming genitals was most prominent during time period 7 which is when the bears were fed fish at a public feeding. Grooming genitals also increased prior to and after this time period. In interpreting this information, also consider the average amount of time the bear sleeps during each time period (Table 5). If this is considered, then time periods 1 through 6 show much more sleeping than time periods 7 and 8 (19.7% to 51.4% compared to 5.7% and 5.6%). The adjusted figures in Table 7 show that the total percent of time spent grooming genitals and pacing in stereotypic patterns is only decreased in time period 5, but more importantly it shows that these behaviors do not significantly increase during time periods when feeding occurs. For this reason, I do not believe that the stereotypy is related to the bears feeding schedule. There is, however, enough evidence to show that fruit presented in unusual ways to the bears causes a reduced rate of stereotypy. As long as these food presentation ideas remain novel there is a chance that stereotypy can be reduced (Carlstead et al. 1991).

### Significance of Social Interactions

There are also social factors that may contribute to the performance of Subject 2's stereotypy. Social interactions seemed unusual in Subject 2, but the question is whether this was causing the stereotypy or whether it was caused by the stereotypy. Because the stereotypies were present before the bear was introduced into the pen at St. Louis Zoo, the stereotypy probably caused the bear to lack some social skills leading to his unusual social interactions. The problem of poor social interaction was not serious, although his tendency to be more aggressive with the female may prevent him from mating with the female if this situation were to arise. His brother, Subject 3, may have an increased breeding opportunity as he has more friendly interactions with the female.

More important socially may be Subject 2's early childhood experiences, of which we have no knowledge. There is a good deal of evidence that childhood experiences can greatly affect stereotypic performance later in life (Mason 1991). As discussed earlier, any abnormal relationship with his mother may have resulted in his stereotypy. When interpreting these ideas it is important to remember that the display of stereotypic movements is greatly dependent on the individual (Mason 1991). Two bears whose lives were virtually the same (such as Subject 2 and Subject 3) may show different rates of stereotypy due to genetics or simple individual predisposition to stress and stereotypy. This increased susceptibility may have caused Subject 2 to react in a more extreme way than Subject 3. Two parts to consider here are that current problems are not always the result of current conditions (Mason 1991), and a sensitive animal may be reacting to factors which are simply not affecting the other animals. A sensitive animal raised in plain, unstimulating surroundings is more prone to stereotypy than those raised in complex pens

(Broom 1981). These plain childhood surroundings combined with any childhood trauma, especially separation from mother, could have created enough mental damage so as to cause stereotypy performance to persist into adulthood.

#### Evidence for Psychological Disorder

There also appears to be some evidence to suggest that Subject 2 may have obsessive compulsive disorder. More evidence is needed to safely conclude that this is an important factor. Also, brain damage and mental retardation have to be excluded before anything can be assumed. More information needs to be gathered before the bear is treated for obsessive compulsive. Due to the cost and time commitment to obtaining further information, other courses of action should first be pursued.

#### Possible Treatments

What can be done then to decrease the incidence of stereotypy in Subject 2? It is important for the animal's pen to provide stimulus similar to those they would encounter in the wild. All three bears climb the ledges and tree in their pen and spend significant amounts of time off the ground. The additional structures recently added are utilized often by all three bears. It is important that they are provided with even more objects to climb and navigate off the ground in their pen, keeping in mind their excellent climbing abilities and affinity for arboreal life. Special effort should be made to add novel items to the bears' cage during rainy days to replace the stimulus usually provided by the viewers. Insuring the bears are receiving a diet consisting of less than five percent meat, like the diet of wild spectacled bears would also be beneficial. Novel feeding methods, like the frozen fruit, should be explored and utilized as often as possible with special effort being made to keep the bears from becoming adjusted to any one method. Keepers described the bears as

being unadjusted to humans. Because of this, every effort should be made to have as little contact as possible with all the bears, but especially with Subject 2.

It is surely evident that whatever initially caused this stereotypy happened prior to the bear being transported to St. Louis from San Diego. It may be that Subject 2 is simply more sensitive than his brother, Subject 3, whose stereotypic behavior has been minimized at St. Louis. It may not be possible to completely eliminate his stereotypy with pen improvements, novel feeding methods, and minimal contact with humans. However, if those actions reduce the stereotypy to levels which will not interfere with the bear's health, socialization with his pen mates, and normal bear activity, then no further treatment would be necessary. In fact, these changes would be beneficial to all three bears. Yet, if these treatments fail to correct the problem, the next step would be to insure that Subject 2 has normal brain function-- to rule out brain damage or mental retardation. Then it may prove helpful to seek a professional who can confirm or deny the presence of obsessive compulsive disorder and prescribe a suitable schedule of treatment. However, these costly procedures should be considered a last resort.

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