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Stereotypic Pacing in Two Imprinted Florida Black Bears *(Ursus americanus floridanus)*

By: Crystal Gagne
Faculty Mentor: Frank Logiudice
UCF Department of Biology

ABSTRACT: Stereotypic pacing is a common occurrence in captive carnivorans. Although stereotypic pacing is typically associated with poor welfare, the cause of pacing is not fully understood. In this study, two captive Florida black bears *(Ursus americanus floridanus)* were observed twice a week for ten weeks, along with zookeeper presence as well as the location and number of guests. Zookeeper presence was associated with a decrease in time spent pacing ($P<0.05$). The male bear in the study spent a larger percent of time pacing in front of guests (average: 43.2% ± 1.0% SD) compared to the female (average: 6.2% ± 1.4% SD), $P<0.05$). Male dominance is the most likely explanation for the variance seen in pacing in front of guests. Observing how guests and zookeepers impact stereotypic pacing can help provide an understanding of the cause of stereotypic pacing and improve the welfare of captive animals.

KEYWORDS: pacing, captivity, animal behavior, American black bear, *Ursus americanus*

INTRODUCTION

The goal of this study is to examine the cause of stereotypic pacing in two captive Florida black bears *(Ursus americanus floridanus)*. Prior to the arrival of the bears at the Central Florida Zoo and Botanical Gardens in Sanford, Florida, they had been taken in by a family in north Florida and raised as pets. The brother and sister bears were confiscated by the Florida Fish and Wildlife Commission (FFWCC), where they were deemed unsuitable for release due to their past interactions with humans. The bears were eventually brought to the Central Florida Zoo in 2014 at approximately eight months of age. The male bear was neutered a year after his arrival at the zoo in order to prevent any aggressive behaviors from developing. The female bear was spayed mid-summer of 2017, which was followed by a marked decrease in aggressive behaviors and activity and an increase in anxious behaviors (UCF Study, 2017). The bears were not put into a viewable enclosure until late in the summer of 2017. Several interruptions, particularly Hurricane Irma, prevented the bears from being kept continually on display until late in the year. At the time of this study, the bears had been continually on exhibit for 6-8 months. Both bears showed a marked interest in people, getting as close to the fence as possible when a person walked too near. Likely due to this tendency and to prevent escape attempts, the bears' viewable enclosure had an electrified fence. The male and female bear had several names, as is consistent with zoo protocol, so to ensure clarity the bears will simply be referred to as "Male" and "Female."

Study Objectives

Few studies have been conducted on the behavior of human-imprinted *U. a. Floridanus*. General behavior of the captive bears was recorded. When the bears first entered the exhibit, the male bear paced more frequently than the female bear. Prior to this study, the zookeepers documented a notable change in the bears' behavior: the female paced more frequently than the male bear. As a result, the zookeepers hypothesized that the female bear would pace more than the male bear. Zookeepers also hypothesized that the bears would increase the amount of pacing when the zookeepers approached the bears, due to the anticipation of food.

One purpose of this study was to determine if there was a significant difference in the amount of pacing done by the male and female bear. Any differences found in the amount of pacing between the bears needed to be analyzed for causes. Outside causes of pacing were analyzed to evaluate their effect on the bears' behavior. These factors included pacing directed towards guests, zookeeper presence, and temporal separation of the bears. During this study, the zookeepers began to let only one bear out into the exhibit at a time. This approach was designed to give both bears a chance to interact with their various enrichment items without disturbance from the other bear.

METHODS

Study Area

The study was conducted within the Central Florida Zoo and Botanical Gardens located in Sanford, Florida. This study took place over ten weeks, beginning on May 21st, 2018 and ending on July 28th, 2018. Both bears were fed the same diet, consisting of bear chow, fresh fruit, sunflower seeds, peanuts, craisins, raisins, and other various fruits that were in season. Enrichment items were given to the bears in equal amounts, with two of each type of enrichment item in the enclosure at a time. Enrichment items include rotten logs from the wooded area surrounding much of the zoo, which likely contained insects, and balls and pipes containing food. Included in the bears' enclosure was a smaller shed area that the bears did not have access to for most of the day. The inside of the shed contained two den areas and two pool areas. On most days after 16:00, the bears were put into the shed area until 09:00 the next morning. An exclusion to this rule were days when cleaning or lawn maintenance was done; the bears would remain in the shed for longer periods of time or would not leave the shed at all. Observations were not made within the shed area.

Within the outside exhibit area, in addition to the enrichment items that were changed near-daily, the bears had access to an enrichment pool, a climbable tree, a wooden treehouse, and several fallen trees. Guests were able to view the bears from several areas. The entrance to the bear viewing area is where guests were closest to the bears. The most northeast portion of the viewing area, the "left arm," allows guests to get near the bears if they were away from the entrance. A small building, called the bear house, serves as a way for guests to view the bears away from the Florida heat. Many windows allow for guests inside of the bear house to get a view of the bears from almost anywhere in the enclosure, with the exception

of a small area behind the treehouse. The layout of the enclosure and viewing area is shown in Figure 1.

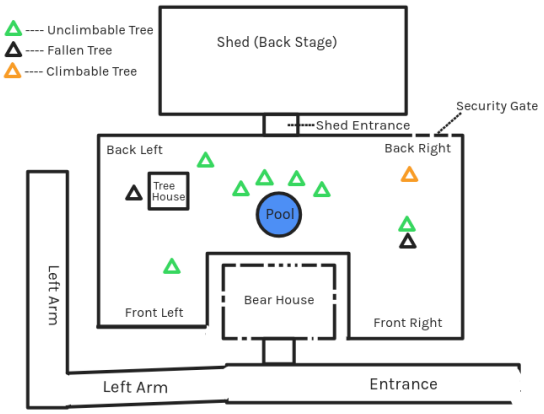

Figure 1. The bears were closed out of the shed and into the viewing area during the day. The viewing area can be divided into three parts: the entrance, bear house, and left arm.

Observational Methods

Approximately nine hours of observations were collected each week over the ten week study period. A total of 86 hours of observations were collected on the bears over this time. Observations were taken from within the bear house in five-hour intervals twice a week, starting at 09:15, when the bears entered the outside area, until 14:15. Observations were typically done on Mondays, Wednesdays, and Fridays. Behavior was documented on an ethogram in five-minute intervals, with notes being taken between the intervals and on the bears' behavior. Behaviors that occupied the majority of the five-minute observation period were recorded as "Primary Behaviors" and were the predominant focus of this study. The recorded behaviors and the definitions are located in Table 1. The location that the behavior was being performed was recorded to evaluate where the bears were spending most of their time.

Guests were counted as they entered the viewing area, and a linear regression was made to evaluate any correlation that may exist between the number of guests visiting the bears' viewing area and the amount of pacing performed by the bears. The R^2 value was calculated to support any correlations found.

A weighted average was calculated for the evaluated behaviors, due to the slight variance in the number of observations between days. The weight used was the ratio of the total number of observations for the day to the total number of observations made over the duration of the study. A weighted standard deviation was also calculated, and the data were evaluated for significance ($P<0.05$) using ANOVA.

There were days where the bears were separated, with one bear kept in the shed and the other bear kept out on exhibit. These days were referred to as "separation days." A total of five separation days were observed. Of the five days, the male bear was on exhibit alone for twice the amount of time the female bear was on exhibit alone. Due to the small amount of data, the effect of separation on the bears could not be fully evaluated.

Behavior	**Definition**
Affiliative	Behaviors where the bears were interacting in a non-aggressive manner. Includes allogrooming, social play, and sitting together.
Agonistic	Behaviors where the bears were interacting aggressively. Includes taking an enrichment item completely away from the other bear, biting, snarling, flashing teeth, swatting, and stomping feet.
Climbing	Locomotion above the ground for a prolonged period of time, as well as attempts to be above the ground on objects that the bears were not fully able to climb.
Foraging	Actively eating or drinking. Includes searching through various enrichment items and through grass for food.
Interacting	In contact with an object in a way that in not purely food motivated. Includes throwing enrichment items in the air, rolling over enrichment items in the absence of food, and stomping on ice blocks after all of the food is gone, among other behaviors. Many behaviors in this category could be described as "play".
Observing	Behaviors where the bears were sniffing the air or enrichment objects, looking at a stimulus, or focusing in a direction.
Other	Behavior not under another definition.
Pacing	Includes all repetitive back-and-forth walking motions. The repetitive walking back-and-forth could be accompanied or unaccompanied by head weaving.
Resting/Sleeping	Sitting or laying and not actively engaged in an active behavior.
Swimming	Prolonged locomotion within the enrichment pool.
Unknown	Where view to the bear is obstructed and the behavior cannot be identified.
Wandering	Locomotion through the exhibit that does not appear to be food or play driven.

Table 1. Lists the behaviors documented on the ethogram and their definitions.

RESULTS

General Behavior

Overall, the bears did not differ much in their general behavior. Oddly, the male bear spent more time swimming than the female bear did ($P=0.0183$).

Differences observed in the amount of pacing were nearly significant (P=0.0519), with the male bear pacing an average of eleven percent less than the female bear. The male bear spent an average of eight percent more time resting/sleeping than the female bear, with nearly significant differences (P=0.0819). The average amount of time each bear spent doing an activity each day is recorded in Table 2.

Behavior	Female	Male
Foraging	8.48% ± 1.96%	8.57% ± 1.96%
Agonistic	0.98% ± 0.23%	1.06% ± 0.24%
Wandering	1.66% ± 0.38%	2.59% ± 0.59%
Interacting	2.92% ± 0.66%	3.75% ± 0.86%
Resting/Sleeping	20.6% ± 4.74%	28.88% ± 6.63%
Affiliative	0.29% ± 0.07%	0.29% ± 0.007%
Climbing	0.58% ± 0.14%	0.48% ± 0.11%
Swimming	0.59% ± 0.14%	1.82% ± 0.42%
Observing	2.05% ± 0.47%	1.83% ± 0.42%
Pacing	61.5% ± 14.2%	50.1% ± 11.5%
Motivation Unknown	0.19% ± 0.05%	0.19% ± 0.04%
Other	0.19% ± 0.05%	0.48% ± 0.11%

Table 2 Shows the weighted average ± the weighted standard deviation for all behaviors for both bears.

Guest Impacts on Behavior

Pacing was the primary focus of this study. As mentioned in Section 3.1, the bears performed most behaviors at similar percentages of their day, excepting swimming, resting/sleeping and pacing. The difference in pacing was nearly significant (P=0.0519). It had been expected that the female bear was pacing much more than the male bear. As shown in Figure 2A, the female bear spent an average of 61.5% (± 14.2% SD) of her day pacing, and the male spent an average of 50% (± 11.5% SD) of his day pacing. When excluding the days of separation, the difference in the amount of pacing the two bears performed was significant (P=0.00627). The female bear is shown to pace more, at an average of 63.2% (± 15.9% SD) of her day, when compared to the male bear, at an average of 48.4% (± 12.3% SD) of his day.

Guest presence was recorded and the location where the bears were pacing was noted, which revealed when the bears were pacing in front of guests. The female bear spent an average of 6.2% (± 1.4% SD) of her pacing in front of guests. The amount of pacing in front of guests the female bear performed was significantly less (P=0.0052) than the pacing performed in front of guests by the male bear, which averaged 43.2% (± 1.0% SD), shown below in Figure 2B. Excluding the days where the two bears were separated, the female bear spent an average of 4.8% (±1.2% SD) of her pacing in front of guests, while the male bear spent an average of 43.5% (± 11% SD), significantly more (P=0.0022).

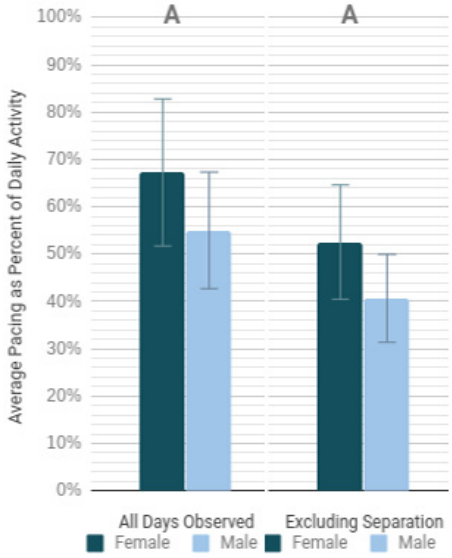

Figure 2.A Shows the average amount of pacing as a percent of daily activity for both the male and female bear. On the right side of the figure is the average percent of the day spent pacing when excluding separation days.

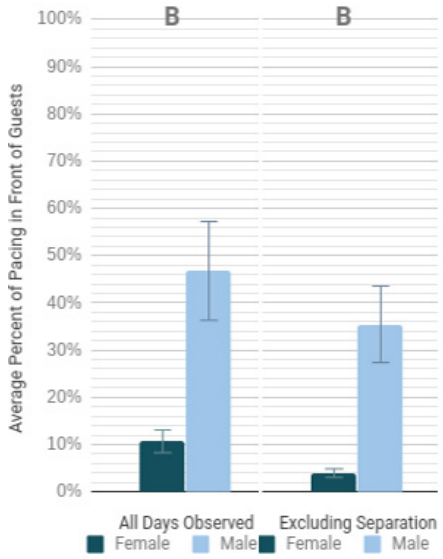

Figure 2.B Show the average percent of pacing that occurs specifically in front of guests for both the female and male bears. On the right side of the figure, the average percent of pacing when excluding separation days is shown.

A linear regression was made to analyze any correlation between the number of guests that visited the viewing area for the day and the amount of pacing the bears were observed performing. Figure 3 displays the linear regression, but there was little to no correlation between the amount of pacing done and the number of guests that visited the exhibit area for the day for either bear. A second linear regression was made, showing the correlation between the amount of pacing in front of guests and the number of guests that visited the viewing area. A very weak positive correlation was shown for the male bear (R^2=0.231), and no correlation was found for the female bear (R^2=0.004), seen in Figure 4.

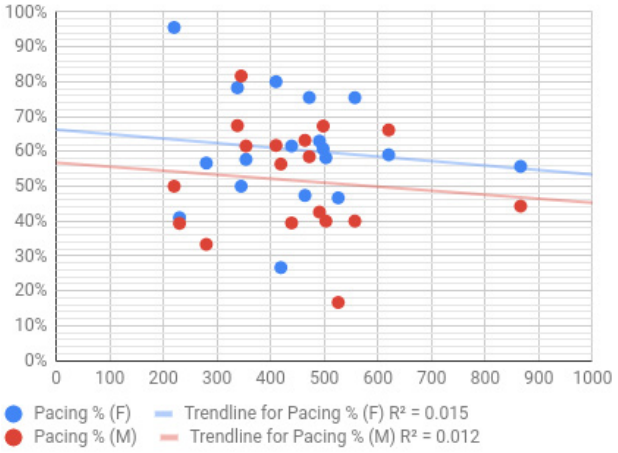

Figure 3. Shows the linear regression of pacing and the number of guests.

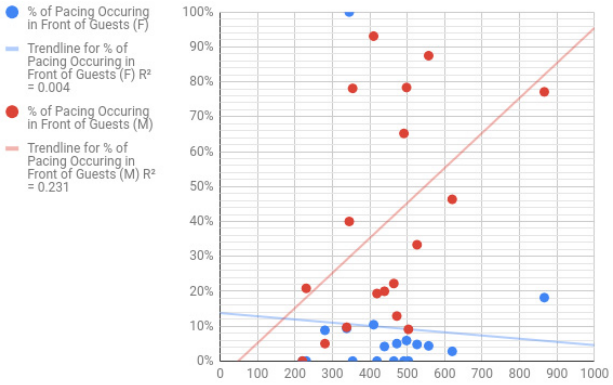

Figure 4. Shows the linear regression of pacing in front of guests and the number of guests that visited the viewing area for the day. A weak trend can be seen in the pacing done by the male bear (Red).

Zookeeper Impacts

The female bear's behavior was compared when the zookeeper was present and when the zookeeper was not present. Zookeeper presence impacted the amount of pacing the female bear did. The average daily percent of pacing without the zookeeper present was 70.7% (± 18.4% SD) verses a 37.4% (± 9.73% SD) with the zookeeper present. This difference was significant (P=0.008). Foraging was also significantly (P=0.003) impacted by zookeeper presence. On average, the female bear foraged for 4.87% (± 1.27% SD) of her time when the zookeeper was not present. With the zookeepers present, she foraged for an average of 16.3% (± 4.25% SD) of her time.

Similarly, the male bear showed significant differences in the amount of pacing (P=0.0196) and foraging (P=0.0015) done depending on zookeeper presence. In addition, the male bear showed a significant difference in the amount of resting/sleeping done based on zookeeper presence (P=0.0145). For the male bear, an average of 14.8% (± 3.81% SD) of the time the zookeepers were present was spent foraging, while an average of 5.49% (± 1.42% SD) of the time without zookeepers was spent foraging. An average of 59.82% (± 15.44% SD) of the male bear's time was spent pacing when the zookeepers were not present. With the zookeepers present, the male bear spent an average of 25.33% (± 6.58% SD) of his time pacing. Only the male bear showed a significant difference in resting/sleeping when the zookeepers were present compared to when they were not. The male bear spent less time resting/sleeping, on average, when the zookeepers were not present (20.55% (± 5.30% SD)) then when the zookeepers were present (48.47% (± 12.53% SD)).

Behavior	Male (No Zookeeper)	Male (With Zookeeper)	Female (No Zookeeper)	Female (With Zookeeper)
Foraging	5.49% ± 1.42%	14.8% ± 3.81%	4.87% ± 1.27%	16.3% ± 4.25%
Agonistic	1.06% ± 0.28%	1.48% ± 0.39%	1.01% ± 0.26%	1.14% ± 0.30%
Wandering	2.82% ± 0.73%	1.85% ± 0.48%	1.17% ± 0.31%	3.05% ± 0.79%
Interacting	5.12% ± 1.33%	2.95% ± 0.77%	2.68% ± 0.70%	3.80% ± 0.99%
Resting/Sleeping	20.6% ± 5.30%	48.5% ± 12.53%	16.0% ± 4.15%	33.3% ± 8.69%
Affiliative	0% ± 0%	0.37% ± 0.10%	0.17% ± 0.04%	0.38% ± 0.10%
Climbing	0.53% ± 0.14%	0.74% ± 0.19%	0.50% ± 0.13%	0.39% ± 0.10%
Swimming	1.59% ± 0.41%	1.48% ± 0.39%	0.50% ± 0.13%	0.76% ± 0.20%
Observing	2.30% ± 0.60%	1.48% ± 0.38%	2.18% ± 0.57%	1.52% ± 0.39%
Pacing	59.8% ± 15.4%	25.3% ± 6.58%	70.7% ± 18.4%	37.4% ± 9.73%
Motivation Unknown	0.35% ± 0.1%	0% ± 0%	0.17% ± 0.04%	1.16% ± 0.30%
Other	0.35% ± 0.1%	1.11% ± 0.29%	0% ± 0%	0.76% ± 0.20%

Table 3. Shows the weighted average ± the weighted standard deviation for all of the behavioral categories of both the female and male bear when the zookeepers were present compared to when they were not present.

DISCUSSION

While it was found that the amount of pacing performed by the two bears was not significantly different, a significant difference was found when excluding the days of separation. The days of separation exposed both bears to a new situation, increasing the amount of pacing performed by the male bear, and decreasing the amount of pacing performed by the female bear, resulting in more similar weighted averages. While outside variables could have had an additional impact on their behaviors, zookeeper presence and guest attendance were similar on days of separation to non-separation days. The weather was typically more sunny and clear on days of separation than average. Due to the male bear's fear of thunder, clear weather was expected to have decreased his pacing activity, however, the opposite was observed on days of separation. As such, separation of the bears was likely the largest factor affecting the bears' behaviors on those days. The male bear was shown to pace less than the female bear, particularly when excluding days of separation. Importantly, both bears spent most of their day pacing, showing a high degree of stereotypic behavior.

The bears paced less when the zookeepers were present. The increase in foraging and decrease in pacing could be a result of the time at which the bears were observed. Zookeepers were present directly after the bears had been let out into the exhibit area for the day, when food had just been distributed throughout the exhibit, which could explain why an increase in foraging was observed in the morning when the zookeepers were present. Occasionally, treats were offered by zookeepers in the middle of the day. Treats were either thrown into the enclosure or placed by hand into the exhibit. After the new food was offered, both bears would forage and the zookeeper would be marked as present. Both bears stopped pacing in order to forage for the treats, leading to the noted increase in foraging when zookeepers were present. An increase in resting/sleeping seen in the male bear when the zookeepers were present was likely due to the time of day. Cleaning of the back shed area occurred several times throughout the study, anywhere from 12:00 to 14:00. The zookeeper would be marked as present while cleaning, and 12:00 to 14:00 corresponds to the time the bears were typically napping. It is possible that the male bear did rest more when the zookeepers were present, but the timing should be considered. Overall, zookeeper presence seemed to improve the welfare of the bears, either directly or indirectly, by breaking up the long periods of uninterrupted pacing.

Pacing in front of guests was performed almost exclusively by the male bear. Both bears were raised by people, so it was expected both would show an interest in guests. The male bear spent nearly half his time pacing in front of guests, while the female bear spent only six percent of her time pacing in front of guests. The male bear was observed chasing the female from the fence closest to the guests, contributing to the difference. In addition, a larger number of guests did not increase the female bear's amount of pacing performed in front of guests, but the number of guests had a small impact on the male bear's amount of pacing in front of guests. Overall, the amount of pacing did not increase or decrease as the number of guests increased, indicating that the guests are not the direct cause of the observed pacing.

The male bear and female bear showed that the male bear paced less and rested more than the female bear. Comfort levels within the enclosure area certainly differ between the male and female bear, with the male bear showing a greater level of comfort, as demonstrated by the lower amount of pacing performed and higher amount of resting/sleeping.

CONCLUSION

Agonistic behaviors between the female and male black bear were frequently followed by the female bear moving into the treehouse to pace. Competition over the area where the bears were pacing, closest to the guests, was observed several times. Enrichment items, including the enrichment pool, were also a point of conflict, with both bears showing an interest in items the other bear was interacting with. Most frequently, it was the female bear that was observed leaving the area following conflict. The female bear may have an interest in guests and be unable to express her interest when the male bear is present. Thus, the female bear may be limited in what she can do by the male bear. It was expected that the two bears would influence each others' behaviors to some degree, but to the extent that the male bear had been observed was not predicted. The male bear paced more when separated from the female, which was the expected result. Both bears had only been separated from each other for a small amount of time prior to this, and it was expected to be stressful for the first couple of times the two were separated. Unexpectedly, the female bear paced less on days where she was separated. The observed decrease in pacing on days of separation is best explained by the lack of competition and territoriality from the male bear.

With both bears being raised by humans, there is some evidence that both bears were interested in the visitors to their exhibit. This is shown by both bears moving to stand against the chain link fence when a person moved into the back shed area with the bears. Finding that the female bear, in particular, did not pace in front of guests more as guest number increased could indicate that something was deterring her behavior. When noting that agonistic behaviors did occur when both bears were pacing in front of guests, typically resulting in the female bear moving to pace elsewhere, it is a reasonable conclusion that the male bear was the deterrent. Giving the bears more space from each other, with less competition over the guests, could mitigate some of the male's aggression and benefit both bears.

Captive bears that are fed more frequently pace less (Clubb and Vickery 2006). These bears would benefit from an increased feeding frequency. An enrichment item that randomly dispenses food throughout the day would perform that function and serve to break up the long, uninterrupted periods of stereotypic pacing the bears were observed performing.

Pacing in captive *U. americanus* has been shown to vary by season, with May and June being the months where pacing is more frequent (Carlstead and Seidensticker, 2001). The motivation behind pacing in these months is attributed to be an urge to look for mates (Carlstead and Seidensticker, 2001). Both of these bears were fixed, but that does not mean that the instinct to search for mates was completely lost. It should be expected to see a reduction in pacing in the fall and winter, regardless of actions taken to improve the bears' welfare. The success of actions taken to improve the bears' welfare will not be fully known until the late spring.

There is a need to begin actions that reduce pacing in both of the bears immediately, because stereotypic behaviors can shift to automatic processing (central processing), which will make further efforts to reduce the amount of pacing more difficult (Mason and Lathan, 2004). In these cases, even removing the initial cause of the behavior will not immediately reduce the stereotyped behavior. Pacing is often associated with poor welfare, and can be an indicator of stress. To ensure the health of both bears, steps should be taken to reduce pacing.
One solution to help mitigate the stereotypic pacing and improve the welfare of the bears may be to open up the shed area during the day. The guillotine doors that lead into the shed had long scratch marks across them from the bears clawing at them, in an attempt to get into the shed. Both bears showed an interest in going back into the shed throughout the day. Stereotyped behaviors are likely caused by a desire to perform an action and an inability to perform the action (Clubb and Vickery, 2006). It is likely that being unable to access the shed is a contributing factor to the observed pacing. In addition, the exhibit area lacks privacy, with only a small corner below the treehouse that is not viewable to guests. Opening the shed would allow the bears to have some privacy from guests, and each other, during the day, another factor that may improve their welfare. Any actions taken to reduce the stereotypic behavior in the bears at the Central Florida Zoo can be evaluated for success in the future, with possible applications for zoos everywhere.

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