

# Environmental enrichment for the captive spectacled bear (*Tremarctos ornatus*)

Michael J. Renner\*, Jennifer Plebani Lussier<sup>1</sup>

*Department of Psychology, West Chester University, West Chester, PA 19388, USA*

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## Abstract

As part a series of investigations of environmental enrichment methods for zoo animals, two spectacled bears (*Tremarctos ornatus*) were observed for 40 h, documenting use of cage space and behaviors, using a detailed ethogram. Baseline data showed concentration of activity into limited areas of the enclosure and expression of a relatively restricted subset of the species' behavioral repertoire. Introduction of a climbing structure resulted in increased behavioral diversity, both in the use of the enclosure's physical space and the behaviors displayed in various parts of the enclosure. © 2002 Elsevier Science Inc. All rights reserved.

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## 1. Introduction

In an earlier monograph (Renner and Rosenzweig, 1987), one of us reported that the applied animal behavior community was only beginning to recognize the value of providing environmental enrichment for captive animals. In the intervening years, that situation has changed completely: Studies of environmental enrichment have extended beyond theoretical studies in the laboratory to a variety of contexts, including zoos, farms, and companion animals; there is an active literature in this area, including journals (e.g., *The Journal of Applied Animal Welfare Science*), dedicated periodicals (e.g., *The Shape of Enrichment*), and a number of excellent edited volumes (e.g., Shepherdson et al., 1998).

Most early applied studies drew heavily on the work of Hediger (1969) and Markowitz (1982). More recent studies, although owing a tremendous debt to these works and those of Rosenzweig (reviewed in Rosenzweig, 1984; Rosenzweig and Bennett, 1996), come from a variety of traditions. Zoo enrichment studies include work done with many species, ranging from primates (e.g., Line et al., 1991; Renner et al., 2000) and large carnivores (e.g., Carlstead et al., 1993;

Markowitz et al., 1995; Shepherdson et al., 1993) to invertebrates (e.g., Anderson and Wood, 2001).

Environmental enrichment for zoo animals often takes different forms than in laboratory studies. Because it is not often feasible to make wholesale changes in the environment on a frequent basis, a variety of other methods are used, including variations in feeding patterns (Byrne and Suomi, 1991), introduction of new and varied scents (e.g., Melo, 1999) or sounds (e.g., Baker et al., 1997), or introduction of stimulus objects (e.g., Renner et al., 2000).

The goals and evaluation criteria of environmental enrichment for captive animal management also necessarily differ from those in laboratory studies. Invasive studies and physiological measures are often impossible, and it is necessary to use other outcome measures. Broadly, enrichment for animal management is typically designed to permit or encourage animals to display their natural behavioral repertoire (Mellen and MacPhee, 2001), including behaviors such as exploration and investigation (Mench, 1994). In addition, captive nondomesticated animals often develop fixed, repetitive, and apparently purposeless behavior patterns, referred to as stereotypies. It is believed that these stereotypies arise when an animal's environment lacks appropriate stimulation. Stereotypic behavior has been documented in many species, including zoo-housed bears (Carlstead et al., 1991). An additional goal of enrichment studies is often to reduce the occurrence of abnormal behaviors such as stereotypies (Carlstead et al., 1991). If

\* Corresponding author. Tel.: +1-610-436-2925; fax: +1-610-436-2846.

E-mail address: mrenner@wcupa.edu (M.J. Renner).

<sup>1</sup> Jennifer Plebani Lussier is now at the University of Vermont.

these goals can be achieved, zoos become better able to fulfill their public education mission, as the visiting public sees behaviors that are more species-typical. Ironically, the general public often misinterprets enrichment regimens, objecting to activities that encourage such natural behaviors as predation, and this can have the effect of reducing the range of activities that are practiced in zoos (McPhee et al., 1998).

This report concerns an environmental enrichment project with the spectacled bear (*Tremarctos ornatus*) in a zoo setting using physical modification of the environment to allow the expression of a broader range of species-typical behaviors. The only previous report of enrichment studies with this species (Fischbacher and Schmid, 1999) varied the materials and locations used for feeding, which produced increases in foraging time but had no other discernable impact on the bears' behavior. The main goal of this project was to document the behavior patterns exhibited by the spectacled bears, to study the effect of introducing environmental changes that permit the expression of a greater variety of species-typical behaviors, and to reduce any stereotypies found.

## 2. Method

### 2.1. Subjects

Subjects in this study were a male–female pair of captive-born spectacled bears (*T. ornatus*), housed at the Philadelphia Zoological Garden. The spectacled bear, also called the Andean Bear, is found in the Andes mountains in western South America. The spectacled bear is the only species remaining from the short-muzzled bears (family Tremarctinae), which were widely distributed in the New World until the Ice Age. Although the habits of the spectacled bear are not well documented, it is known that this species is the most arboreal of the bears, spending considerable time in trees in the wild (Nowak, 1999). Most existing populations are fragmentary due to habitat destruction (Nowak, 1999), and the species is classified as endangered under the CITES treaty (United Nations, 1973).

The male, “BooBoo,” was approximately 19 years old at the time of the project. The female, “Suzy,” was approximately 12 years old. The bears were housed in separate underground dens when the zoo is closed, and were released into the enclosure each morning. The management routine included delivery of the primary daily feeding in the dens at the end of the day, and so the bears entered voluntarily when the den doors were opened in late afternoon.

### 2.2. Procedure

Behavior and location data on both bears were collected using a scan sampling method. An ethogram was constructed based on observed behaviors, and amended during

the course of the research in order to include a code for copulatory behavior (the ethogram is shown in Table 1). As is shown in Fig. 1, the enclosure was visually divided into

Table 1  
Bear behavior ethogram

Operational definitions	
Walk, nose up	The bear is engaged in nonrepetitive locomotion with its nose one head width or more above the ground and one head width or more away from the nearest object.
Walk, Nose down	The bear is engaged in nonrepetitive locomotion with its nose within one head width of the ground and one head width or more away from the nearest object.
Pace	Walking repeatedly in the same path, usually in a cyclic pattern.
Dig/scratch	Movement of paws against object or ground, such that the surface of the object or ground could reasonably be disrupted by the action. Often repeated or patterned.
Eat/drink	Consumption of food or fluid. Includes movements of the head and face in proximity to food or water sufficient to infer that consumption is occurring.
Groom	Repeated movement of face or paws over another body part.
Face Rub on object, nontransient	Any part of the face rubbing on an object, usually repeated. Excludes transient contact while in locomotion.
Body rub on object, nontransient	Any part of the body exclusive of face rubbing on an object, usually repeated. Excludes transient contact while in locomotion.
Manipulate/sniff moveable object	The bear's face is within one head width of the nearest object. The forepaws may be in contact. Excludes transient occurrences while bear is in locomotion.
Forepaws only on object	One or both forepaws on a fixed object that projects above the plane of the surrounding ground, with at least one rear paw remaining on ground.
All or rear paws on object	Rear paws on an object that projects above the plane of the surrounding ground, regardless of location of forepaws.
Climb Tree	Arboreal activity, with animal in a tree where simple locomotion would not suffice. Should include use of claws for gripping; usually involves vertical body position.
Stand on Hind legs	Bear is vertical or nearly upright position.
Stationary, eyes Open	Bear is not engaged on other codable activity, and eyes are visibly open.
Stationary, eyes Closed	Bear is not engaged on other codable activity, and eyes are not visibly open.
Social, apparently amicable	Bear is in proximity to the other bear, and activity does not have aggressive characteristics (as described below).
Social, apparently aggressive —X	Bear is in proximity to the other bear, and activity has aggressive characteristics (e.g., paw swipes, audible vocalizations, bared teeth).
Not Visible	The bear is in the enclosure, but its actions are not observable.

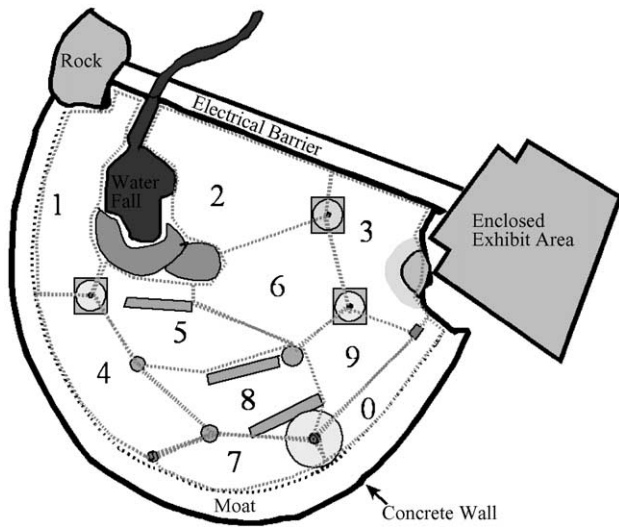


Fig. 1. Map of the spectacled bear enclosure at the Philadelphia Zoological Garden, including zones used for coding bear location.

zones, which were reliably discriminable by sight using landmarks and replicable sight lines (e.g., establishing a boundary using an imaginary line drawn between two easily visible objects). Data were collected in 60-min periods with each animal's location and behavior recorded once per animal per minute. Forty hours of baseline data were collected over approximately 40 weeks at varying times of day.

Following baseline data collection, the climbing structure was installed on the boundary between zones 5 and 8 by the zoo staff. It consisted of a four-sided base of heavy timbers, with triangular platforms at approximately 1.5 and 2.5 m above ground level. Two horizontal arms extended from the level of the first platform, into which heavy eye hooks had been set; objects could be fastened to these eye hooks and hung from them. After the introduction of the climbing structure, 25 h of postenrichment data were collected and analyzed over approximately 20 weeks using the same methods as those for the baseline data, with the addition of location code for the climbing structure.

Subsequent to this installation was the addition of novel objects into the bears' enclosure, hung from eye hooks on the climber with lengths of chain completed into loops and hung with carabiners. These objects contained embedded food that could be extracted by the bears. The first item was an ice block with apple quarters inside (Ice Block), the second a tire with omnivore chow inside (Tire), and the third two small ice blocks on chains with frozen fruit inside each (Double Chain). Videotape of the first hour after addition of each enrichment item was analyzed for each bear's total contact time with each of the three novel objects. Objects were removed daily and exchanged for other objects; while out of the enclosure, they were examined and any that had sustained damage was retired from use.

### 3. Results

Animal keepers reported prior to data collection that pacing in front of the door to the indoor quarters was the predominant stereotypy for BooBoo, while Suzy exhibited long periods of inactivity. These informal observations were confirmed by the structured observations during the baseline period.

After the construction of the climbing structure, BooBoo spent 2% of his time on the structure, and Suzy spent 8% of her time on it. The bears were rarely seen on the structure at the same time. There was apparent trend in the data that use of the structure increased over the first few weeks after installation and then stabilized, but there were not a sufficient number of observations to permit statistical analysis. The addition of the climbing structure also created significant changes in the ways the bears used the other available space in the enclosure. After removing time spent on the climber and times for which the bear's location could not be determined, the spatial distribution of time spent in the zones changed significantly for both bears [BooBoo: chi-square ( $df=12$ )=647.72,  $P<.01$ ; Suzy:  $\chi^2$  ( $df=12$ )=286.93,  $P<.01$ ].

The installation of the climbing structure also generated significant changes in overall behavior patterns of the bears [BooBoo: chi-square ( $df=12$ )=680.21,  $P<.01$ ; Suzy:  $\chi^2$  ( $df=12$ )=480.25,  $P<.01$ ]. Both bears spent less time engaged in motionless, eyes-open behavior (BooBoo reduced from 25% to 16%; Suzy decreased from 36% to 26%) and more time feeding in the enclosure (BooBoo increased from 4% to 16%; Suzy increased from 5% to 6%). There was a decrease in BooBoo's pacing behavior, from 20% to 14%. Suzy spent less time sleeping in the enclosure, 9%, as compared to 16% during the baseline period. Although the amount of time in which BooBoo was not visible decreased from 34% to 21%, the opposite was true for Suzy, increasing from 22% to 48%.

Both bears investigated the novel objects, as shown in Fig. 2. Analysis of the videotapes of object contact reveals a

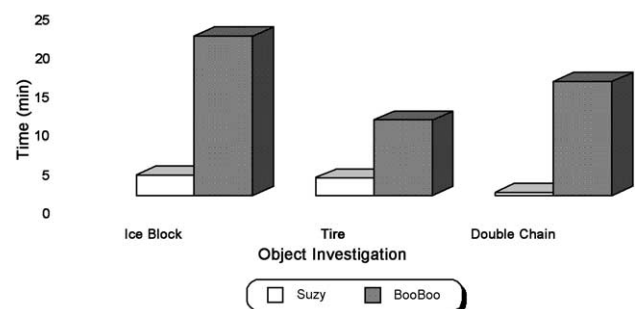


Fig. 2. Investigation of novel objects.

pattern of approach and retreat towards the novel objects. When the animals are unable to extract additional food from an object, they had little or no additional contact with the objects.

#### 4. Discussion

The ideal endpoint of captive animal enrichment is to provide an environment in which the behavior pattern and time budget of captive animals approximate that of non-captive animals. In the absence of adequate field data on behavior patterns in noncaptive animals, a reasonable interim standard is the reduction of extended periods of inactivity (except where those are known to be species-typical), reduction of stereotypies, and display of relatively diverse array of species-normal behavior patterns.

In this study several behavioral changes may be attributed to the introduction of the climber and enrichment items. In addition to the bears climbing on the structure itself, they also initiated a general pattern of climbing on other objects in their environment since the introduction of the climber. This increase in climbing behavior appears to make the captive bears' behavior more similar to the arboreal behavior believed to be typical of wild spectacled bears (Nowak, 1999).

Both bears enter the enclosure immediately upon release rather than remaining by the entrance to their night quarters. Additionally, they remain in closer proximity to each other without aggressive interactions slightly more often than they had prior to enrichment. BooBoo's pacing and Suzy's motionless sitting have been reduced at the same time that the general activity levels of both animals have increased.

Analysis of the videotapes of object contact reveals a pattern of approach and withdrawal towards the novel objects. Both animals visited the ice blocks more frequently as they melted, and seemed willing to wait as the fruit within the ice blocks became exposed enough to extract from the ice. Also, when the animals were no longer able to extract food from the tire, they preferred foraging elsewhere to continued manipulation of the hanging tire. BooBoo spent more time in contact with the novel items than Suzy, possibly because he is larger, and thus better able to reach and manipulate the objects. It is also possible that BooBoo's presence near the novel items deterred Suzy from approaching them as much as she might otherwise have done. During behavioral data collection, the bears did not typically inhabit a zone simultaneously, but these data do not directly address the possibility that they actively avoid each other.

The addition of the climber and novel enrichment items into the spectacled bears' enclosure led to a decrease in the previously exhibited stereotypies of both animals, as well as a more varied behavior pattern and more widely dispersed utilization of the enclosure space. These changes are evidence of small but noticeable improvements in the welfare of the bears. Additionally, the climber and novel items have resulted in apparently greater interest from the zoo-going

public, increasing awareness of these bears, and thereby of their endangered status.

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#### References

- Anderson RC, Wood JB. Enrichment for Giant Pacific Octopuses: happy as a clam? *J Appl Anim Welfare Sci* 2001;4(2).
- Baker WK, Campbell R, Gilbert J. Enriching the pride: scents that make sense. *Shape Enrich* 1997;6(1):1–3.
- Byrne GD, Suomi SJ. Effects of woodchips and buried food on behavior patterns and psychological well-being of captive rhesus monkeys. *Am J Primatol* 1991;23(3):141–51.
- Carlstead K, Seidensticker J, Baldwin R. Environmental enrichment for zoo bears. *Zoo Biol* 1991;10:3–16.
- Carlstead K, Brown JL, Seidensticker J. Behavioral and adrenocortical responses to environmental changes in leopard cats (*Felis bengalensis*). *Zoo Biol* 1993;12(4):321–31.
- Fischbacher M, Schmid H. Feeding enrichment and stereotypic behavior in spectacled bears. *Zoo Biol* 1999;18(5):363.
- Hediger H. Man and animal in the zoo. New York: Delacourt Press, 1969 (Vevers G, Reade W, Trans.).
- Line SW, Markowitz H, Morgan KN, Strong S. Effects of cage size and environmental enrichment on behavioral and physiological responses of rhesus macaques to the stress of daily events. In: Novak MA, Petto AJ, editors. Through the looking glass: issues of psychological well-being in captive nonhuman primates. Washington (DC): American Psychological Association, 1991. pp. 160–79.
- Markowitz H. Behavioral enrichment in the zoo. New York: Van Nostrand-Reinhold, 1982.
- Markowitz H, Aday C, Gavazzi A. Effectiveness of acoustic "prey": environmental enrichment for a captive African leopard (*Panthera pardus*). *Zoo Biol* 1995;14:371–9.
- McPhee ME, Foster JS, Sevenich M, Saunders CD. Public perceptions of behavioral enrichment: assumptions gone awry. *Zoo Biol* 1998;17(6): 525–34.
- Mellen J, MacPhee MS. Philosophy of environmental enrichment: past, present, and future. *Zoo Biol* 2001;20(3):211–26.
- Melo L. Auditory enrichment for Asian elephants. *Shape Enrich* 1999; 8(2):1–4.
- Mench J. Enrichment and exploration. *Lab Anim*. 1994;38–41 (February).
- Nowak RM. 6th ed. Carnivora: Ursidae: *Tremarctos ornatus*, Walker's mammals of the world, vol. 1. Baltimore: Johns Hopkins University Press, 1999. pp. 680–1.
- Renner MJ, Rosenzweig MR. Enriched and impoverished environments: effects on brain and behavior. New York: Springer-Verlag, 1987.
- Renner MJ, Feiner AJ, Orr MG, Delaney BA. Environmental enrichment for new world primates: introducing food-irrelevant objects and direct and secondary effects. *J Appl Anim Welfare Sci* 2000;3(1):23–32.

Rosenzweig MR. Experience, memory, and the brain. *Am Psychol* 1984; 39(4):365–76.

Rosenzweig MR, Bennett EL. Psychobiology of plasticity: effects of training and experience on brain and behavior. *Behav Brain Res* 1996; 78(1):57–65.

Shepherdson DJ, Carlstead K, Mellen JD, Seidensticker J. The influence of food presentation on the behavior of small cats in confined environments. *Zoo Biol* 1993;12(2):203–16.

Shepherdson DJ, Mellen JD, Hutchins M. *Second nature: environmental enrichment for captive animals*. Washington (DC): Smithsonian Institution Press, 1998.

United Nations. *Convention on international trade in endangered species of wild fauna and flora*. Geneva, Switzerland: United Nations Environmental Programme, 1973.