

# STIMULATING NATURAL BEHAVIOR IN CAPTIVE BEARS

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**Abstract:** Brown bears (*Ursus arctos*) in zoos are often kept under sub-optimal conditions and have behavioral time-budgets that differ from their wild counterparts. We conducted 2 experiments using novel feeding conditions for captive European brown bears (scattering food rather than piling and increasing feeding frequencies from 3 to 6/day) in the Bear Forest (BF), a 2-ha forested enclosure in Rhenen, the Netherlands. No significant differences in any behavioral category were found when food was scattered rather than piled. We found significant differences in active and foraging behavioral categories when feeding was increased from 3 to 6 times daily, suggesting a more natural behavioral pattern. We speculate that this effect will increase when scattering food and increasing feeding frequency are combined into a new feeding condition.

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When humans take care of the daily needs of captive animals, they obviate the need for the animals to forage and handle food themselves. Thus captive animals have more spare time than their wild counterparts (Veasey et al. 1996, Koene 1997). This often leads to unnatural behavior patterns in captive animals, such as high percentages of time spent on inactive or stereotypic behavior.

To fulfil their educational role and to improve animal welfare, zoos must stimulate their captive animals to behave as their wild counterparts do (Forthman et al. 1992, Dobberstine 1994, Young 1997). Accurate education of the public about wild animals is difficult when their captive representatives are maintained in enclosures that substantially suppress or change natural behavior patterns. Animals in a more natural environment behave more naturally and are thus better promoters of habitat and species conservation. Inducing a more natural behavior pattern can also contribute to captive animal welfare (Veasey et al. 1996, Young 1997).

Zoos can stimulate natural behavior in their captive animals through environmental enrichment. This is most successful when the complexity of the enclosures is increased with species-appropriate furnishings and when feeding encourages complex feeding behaviors (Markowitz 1982, Carlstead et al. 1991, Forthman et al. 1992, Dobberstine 1994, Coulton et al. 1997). Spatial and temporal variability of the captive environment also contributes to enrichment (Markowitz 1982, Carlstead et al. 1991, Forthman et al. 1992). Although too much unpredictability can reduce animal welfare, the absence of variability is highly artificial because the natural habitat also changes from day to day (Poole 1997).

Brown bears in the wild spend approximately 50% of their time on active behaviors (Roth 1983), of which approximately 50% is spent on foraging activities (Atwell et al. 1980, Phillips 1987). Because most brown bear food

items are small, numerous, and scattered, bears need a large amount of time to collect and consume their food in sufficient quantities (Carlstead et al. 1991). Thus a major part of the natural behavioral repertoire of brown bears consists of foraging and food handling activities. By increasing the opportunities for brown bears in captivity to forage, their explorative and manipulative behavior is stimulated, consequently challenging the animals on a cognitive level. It is also likely that their time-budget will change to better resemble that of their wild counterparts.

At least 3 quantitative studies of changing feeding conditions in captive bears have been published (Markowitz 1982, Carlstead et al. 1991, Forthman et al. 1992). The feeding conditions reported in these studies mainly used man-made items to stimulate natural behavior in bears. In the enclosure for European brown bears in Ouweland Zoo managed by the International Bear Foundation (IBF), we decided to implement a feeding regime eschewing feeding devices, because one of the purposes of IBF is to educate the public about bears and their natural habitat. Our objectives were to test 2 feeding conditions based on the natural foraging behaviors of brown bears: varied spatial concentration of food (piled vs. scattered food) and varied frequency of feeding times. We hypothesized that changing these aspects of bears feeding regimen would alter time-budgets to become more similar to those in the wild.

## METHODS

### Enclosure

The bears in this study live in a 2-ha forested enclosure called the Bear Forest (BF), in Ouweland Zoo, Rhenen, The Netherlands. The BF provides shelter to confiscated, maltreated European brown bears, such as former danc-

ing bears, circus bears, and surplus bears. Bears share the BF with a pack of 6 wolves (*Canis lupus*). The BF emulates a natural environment due to the presence of soil, trees, shrubs, ground vegetation, a creek, and (artificial) dens. Most bears and wolves are out all day (they use the dens mainly during winter) and can be seen from the public walkway that divides the enclosure into 2 compartments. All bears and wolves have access to both compartments through 3 passages beneath the walkway. A double wire netted fence and a low electric fence bound the BF. A quarantine facility for veterinary care is adjacent to the enclosure.

## Animals

We used 13 bears (6 males and 7 females) in the first experiment and 11 (5 males and 6 females) in the second. All male bears and male wolves were sterilized to prevent reproduction. Two male bears and 1 female bear (all dancing bears) were blinded by their former owners. The second experiment had a lower sample size because 2 animals died between the experimental periods (1 blind female, 1 male).

## Experimental Procedure

The first experiment was designed to assess the effects of spatial concentration of food, and the second experiment tested the effects of a change in frequency of feeding. Each 10-day experiment consisted of 5 days of the control (normal) condition and 5 days of one of the enriched (new) condition. Control days and enriched days were randomized (within the 10-day period) to minimize the confounding effects of extraneous variables (e.g., weather conditions) on bear activity. All bears within the enclosure were exposed to identical feeding regimens on any given day. Within each experiment, the amount of food and the contents of the diet did not vary between control and enriched days. However, because the bears are fed a 'natural' diet that changed every few weeks, the amount of food increased and the contents of the diet changed between the 2 experiments.

We classified behavior into 33 categories, which were further grouped into 6 main categories during analysis: active (e.g., walking, running, sniffing while walking); inactive (e.g., lying down, grooming); food (e.g., eating, drinking, manipulating food items); interaction (e.g., playing, fighting, chasing); stereotypy (e.g., stereotypic locomotion, stereotypic head tossing); and other (e.g., behavior other than described or bear temporarily out of sight). Additionally, 2 behavioral categories were analysed separately: sniffing while walking, and manipulating food items.

Separate analyses were conducted of behavior during each day (including and excluding feeding times) and

during each feeding time (from food distribution until ½ hour afterwards). In all cases, scores for each behavior were calculated as the mean number of instances per bear per observation period. Control and experimental conditions were compared using the Wilcoxon rank test (SAS Institute, Inc. 1990), and significance was considered  $P < 0.05$ .

## Spatial Concentration of Food

During the 5 control days, food was offered to all bears at the locations they normally gathered during feeding time (piled food), 3 times/day (830, 1315, and 1630). During the 5 enriched days, bears were fed at the same 3 times a day, but the food was scattered around the usual locations. The experiment took place from 8–17 April 1999. We observed bear behavior every 10 minutes from 800 until 1730 using instantaneous scan sampling (Martin and Bateson 1993), during 80 hours of observations.

## Frequency of Feeding Times

During the 5 control days, food was offered to bears 3 times/day (830, 1315, and 1615) at the locations they normally gathered during feeding time. During the 5 enriched days, food was offered at the same locations an additional 3 times (extra feeding times at 1000, 1130, and 1430; total of 6 feeding periods). The total quantity of food per day was unchanged between control and experimental regimes. The experiment took place from 15–24 June 1999. We observed bears' behaviors every 10 minutes from 800 until 1700 (Martin and Bateson 1993), resulting in 80 hours of observations

## RESULTS

### Spatial Concentration of Food

We observed no significant differences between control (piled food) and enriched (scattered food) conditions for any of the 6 behavioral categories ( $P > 0.050$ , Table 1). We did not observe significant differences when considering the 2 species-typical behaviors 'sniffing while walking' and 'manipulating food items' ( $P > 0.050$ , Table 2).

### Frequency of Feeding Times

Mean time bears were active was significantly higher during the experimental periods (6 feeding times) than control periods when including observations of the entire day ( $P = 0.016$ , Table 3). During all 3 extra feeding times the bears spent significantly more time on food-related behavior ( $P = 0.009$ ,  $P = 0.008$ , and  $P = 0.036$ , respectively) and less on inactive behavior ( $P = 0.009$ ,  $P = 0.016$ , and  $P = 0.009$ , respectively) than during the correspond-

**Table 1. Mean percent time spent by captive brown bears on behavioral categories for control (piled food; A) and enriched (scattered food; B) conditions. Differences between control and enriched conditions were all not significant ( $P > 0.05$ ). Feeding times 1–3 were respectively 0830, 1315 and 1615.**

Time of day	Behavioral category											
	Inactive		Active		Food		Interaction		Stereotype		Other	
	A	B	A	B	A	B	A	B	A	B	A	B
All day (including feeding times)	50.7	49.0	21.0	21.1	8.7	9.3	9.2	8.2	4.6	3.2	5.8	9.3
All day (excluding feeding times)	56.5	55.7	17.7	15.9	4.5	4.7	10.5	9.1	5.1	3.5	5.6	11.1
Feeding time 1	41.2	30.8	25.8	28.1	19.6	28.8	4.6	6.2	1.5	1.9	7.3	4.2
Feeding time 2	33.4	27.7	32.3	38.5	18.1	22.7	7.3	4.6	4.2	1.5	4.6	5.0
Feeding time 3	25.8	27.7	33.8	43.5	25.8	17.3	3.8	6.2	3.8	3.1	6.9	2.3

**Table 2. Mean percent time spent by captive brown bears on species-typical behaviors for control (piled food; A) and enriched (scattered food; B) conditions. Differences between control and enriched conditions were all insignificant ( $P > 0.05$ ). Feeding times 1–3 were respectively 0830, 1315, and 1615.**

Time of day	Species-typical behavior			
	Sniffing while walking		Manipulating food items	
	A	B	A	B
All day (including feeding times)	2.7	3.1	0.3	0.7
All day (excluding feeding times)	2.3	2.0	0.3	0.2
Feeding time 1	1.2	5.0	0.4	4.2
Feeding time 2	6.2	8.5	0.0	2.3
Feeding time 3	4.6	6.2	1.5	3.1

ing time periods for the control. During 2 of the extra 3 feeding times, bears also spent significantly more time on active behavior (both  $P = 0.009$ ) than the corresponding control period. During feeding time 4, the time spent on food-related behavior was significantly lower ( $P = 0.036$ , Table 3) than in the control.

A significant increase was found during the enriched conditions for the species-typical behavior ‘sniffing while walking’ during feeding times 1, 2 (extra), and 3 (extra;  $P$

$= 0.014$ ,  $P = 0.017$ , and  $P = 0.016$ , respectively, Table 4). No significant difference was found for ‘manipulating food items’ between control and enriched (extra feeding times) considered during the entire day or per feeding time ( $P > 0.050$ , Table 4).

## DISCUSSION

When the spatial distribution of food was changed, no significant difference was found in any behavioral category. We noted a tendency toward more time spent on ‘sniffing while walking’ and ‘manipulating food items’ during feeding times, although these were not statistically significant at  $P < 0.05$  (Table 2). We believe scattering of food contributed toward this tendency, because bears were forced to sniff, manipulate, and walk more to find their food. The lack of significant differences might be due to the method of offering food during this experiment. Because the scattered food was thrown from the public walkway by an animal caretaker wearing a green jacket (just as in the control condition), the bears may have reacted to the caretaker’s movements and relatively quickly found food wherever it was distributed. The difference in distances the bears had to cover to find food also may have been too small between control and enriched conditions.

**Table 3. Mean percent time spent by captive brown bears during control (3 feedings/day; A) and enriched (6 feedings/day; B) conditions. Feeding times 1–6 were respectively 0830, 1000, 1130, 1315, 1430, and 1615.**

Time of day	Behavioral category											
	Inactive		Active		Food		Interaction		Stereotype		Other	
	A	B	A	B	A	B	A	B	A	B	A	B
All day (including feeding times)	54.0	51.0	21.6	25.3 <sup>a</sup>	11.6	13.9	7.3	5.4	0.1	0.1	5.4	4.3
All day (excluding feeding times)	62.7	69.2	17.9	14.4	5.3	4.3	7.7	5.8	0.1	0.0	6.3	6.3
Feeding time 1	35.9	30.9	36.4	44.1	17.3	19.1	3.6	2.7	0.4	0.0	6.4	3.1
Feeding time 2 (extra)	83.0	32.1 <sup>a</sup>	4.8	35.1 <sup>a</sup>	3.0	23.0 <sup>a</sup>	3.6	6.1	0.0	0.0	5.5	3.6
Feeding time 3 (extra)	65.0	30.5 <sup>a</sup>	17.3	30.5	3.6	30.5 <sup>a</sup>	10.5	7.3	0.0	0.0	3.6	1.4
Feeding time 4	15.9	32.3 <sup>a</sup>	35.9	39.5	40.9	22.3 <sup>a</sup>	5.5	4.5	0.0	0.5	1.8	0.9
Feeding time 5 (extra)	66.4	23.9 <sup>a</sup>	13.0	44.5 <sup>a</sup>	4.2	26.7 <sup>a</sup>	8.5	3.0	0.0	0.0	7.9	1.8
Feeding time 6	12.3	24.1 <sup>a</sup>	39.1	37.3	37.3	31.8	9.1	5.0	0.0	0.0	2.3	1.4

<sup>a</sup>  $P < 0.05$

**Table 4. Mean percent time spent by captive brown bears on species-typical behaviors during control (3 feedings/day; A) and enriched (6 feedings/day; B) conditions. Feeding times 1–6 were respectively 0830, 1000, 1130, 1315, 1430 and 1615.**

Time of day	Species-typical behavior			
	Sniffing while walking		Manipulating food items	
	A	B	A	B
All day (including feeding times)	2.4	3.8	1.0	0.6
All day (excluding feeding times)	1.5	1.6	0.8	0.4
Feeding time 1	3.6	8.6 <sup>a</sup>	1.8	0.9
Feeding time 2 (extra)	0.0	4.2 <sup>a</sup>	1.8	1.2
Feeding time 3 (extra)	1.4	5.4 <sup>a</sup>	0.0	0.5
Feeding time 4	6.4	8.1	1.4	0.9
Feeding time 5 (extra)	0.6	5.5	0.6	1.2
Feeding time 6	6.4	5.5	1.8	0.0

<sup>a</sup> P < 0.05

When compared to their wild counterparts, BF bears had easy access to their food under both conditions. It may have been more effective to hide food items throughout the entire enclosure, thereby stimulating bears to explore their enclosure, to use their sense of smell, and to work for their food. However, hiding food has had mixed results (Ames 1998), and would in any case require keepers to place food in a wide variety of places.

When frequency of feeding times was increased from 3 to 6, percent time spent 'active' was higher daylong. The species-typical behavior 'sniffing while walking' also increased during 3 of the 6 periods. During extra feeding times an increase in food-related behaviors and a decrease in inactive behavior was found. This affected the mean time spent on food-related and inactive behaviors. In total, bears spent 44.6% of their time on active type behaviors (summing active, foraging and interactions) during the enrichment experiments, compared to 40.5% in the control condition. This is closer to the 50% of time-budgets spent on active behaviors in wild bears (Roth 1983), and thus we interpret the second experiment to have stimulated more natural behavior.

We speculate that bears at the BF would have shown yet greater activity had scattered food and increased frequency of feeding times been combined in one new feeding condition. This new feeding condition, together with a diet composition that resembles a 'natural' diet, is now implemented in the feeding schedules of IBF.

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