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RESEARCH ARTICLES

Environmental Enrichment for Zoo Bears

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The high incidence of stereotypic behaviors in zoo bears (van Keulen-Kromhout: *International Zoo Yearbook* 18:177–186, 1978) suggests that the environment of these animals lacks essential stimuli for guiding normal behavior. Three experiments investigated ways in which bear husbandry procedures can be altered to promote normal behavior. In experiments 1 and 2, honey-filled logs were given to a sloth (*Melursus ursinus*), American black (*Ursus americanus*), and brown bear (*Ursus arctos*) to determine 1) the role of food in stimulating investigatory behavior, 2) the rate of habituation to manipulable objects introduced into the exhibit, and 3) effects on locomotory behaviors. Results show specific and general habituation to the introduced objects that can be counteracted by refilling the logs with honey and by providing multiple logs in the exhibit. Investigatory activity directed toward honey-logs replaces pacing and walking in the sloth bear and is most effective in doing so when the log is novel. Experiment 3 examined the behavioral effects of feeding an American black bear in three different ways: 1) once daily in the den, 2) once daily with supplemental food from a mechanical feeder, and 3) once daily with food hidden in the exhibit in manipulatable objects. The latter method reduced stereotypic pacing from a median of 150 min/day to 20 min/day; the mechanical feeder method had no such effect. The results of a survey of 67 zoos concerning the diet and manner of feeding these three species of bears, as well as Asian black bears (*Ursus thibetanus*) are presented. Results are discussed with respect to the ways in which husbandry procedures can be improved to stimulate functional foraging and feeding behavior in confined bears.

Key words: object manipulation, feeding, foraging, husbandry procedures, cage furnishings, stereotypic behavior

INTRODUCTION

It is generally recognized that naturalistic, functional behaviors can be promoted in confined animals by increasing the physical complexity of their environments with species-appropriate furnishings, and by adopting methods of feeding that encourage complex feeding behaviors [Hediger, 1950, 1966; Morris, 1962, 1964; van Keulen-Kromhout, 1978; Markowitz, 1978; Hancocks, 1980; Forthman Quick, 1984; Hutchins et al., 1984]. Much attention has been directed toward the behavioral

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benefits of enriching the environment of zoo- and laboratory-housed primates, but the importance of providing environmental stimulation for captive bears has not been adequately recognized. A chronic problem among confined bears is the development of morphologically fixed, repetitive, apparently purposeless behavior patterns, termed stereotypies [Holzapfel, 1939; Meyer-Holzapfel, 1968]. In a survey of 58 zoos [van Keulen-Kromhout, 1978] and a survey of polar bears (*Ursus maritimus*) exhibited in British zoos [Horseman, 1986], 60% of all bears were reported to perform stereotypic behaviors. Stereotypies may develop when an animal's environment is lacking stimulation to guide or shape appetitive behaviors into functional sequences [Morris, 1964; Fentress, 1976; Ridley and Baker, 1982].

Bears in the wild spend considerable portions of their time foraging for a wide variety of food items; American black bears (*Ursus americanus*), for example, spend up to 18 hours/day foraging [Garshelis and Pelton, 1980; Rogers, 1987]. Brown bears (*Ursus arctos*) in Europe are active 45–60% of the day and night [Roth, 1983; Roth and Huber, 1986], and 94% of the active time in North American brown bears is spent foraging [Stelmock and Dean, 1986; Gebhardt, 1987 in Jonkel, 1987]. The activity levels of an American black bear and a brown bear exhibited at the National Zoological Park are similar to those reported for free-ranging bears: 49–54% when averaged across the year. However, only 12–20% of the activity of these captive bears is spent exploring or foraging; the remainder is spent mainly in locomotion or stereotypic pacing (40–60%) or sitting (12–21%) [Baldwin, unpubl. data].

Many zoos exhibit bears in enclosures that are impoverished in terms of stimulation that encourages functional investigative or manipulative activity. Also, captive bears are usually fed an unvarying diet in one daily portion that requires no foraging activity; food is simply placed in front of the animals. Nevertheless, even the most barren exhibit spaces can be changed to provide stimulation by implementing different husbandry procedures. van Keulen-Kromhout [1978] suggested that increasing the number of feedings and scattering food would increase and qualitatively improve bear activity, and multiple daily feedings in which polar bears must retrieve food from a pool have been anecdotally reported to decrease the incidence of stereotypic behavior [Schmidt and Markowitz, 1977; Law and Boyle, 1986]. Floating toys such as beer kegs, plastic balls, and small logs may stimulate aquatic play in brown and polar bears (pers. obs.).

This paper addresses how naturalistic behavior in zoo bears can be promoted by changing the way they are fed. Experiments in which bears are given the opportunity to manipulate exhibit furnishings to obtain food have been carried out on three bear species exhibited at the National Zoological Park (American black bear, brown bear, *U. a. middendorffi,* and sloth bear, *Melursus ursinus*). In experiments 1 and 2, simple, manipulatable toys that contained food (honey-filled spruce logs) were given to a single individual of the above three species. Behavioral observations were carried out to determine 1) the role of food in stimulating object investigation, 2) how quickly bears habituate to manipulatable objects placed in their yard, and 3) the effects of object investigation on locomotory activities. In experiment 3, the effects of varied feeding techniques on the behavior of the American black bear were examined. The frequencies of stereotypic pacing and other behaviors were observed under three methods of feeding: one daily meal, a supplemental food-dispensing device, and hiding food in the exhibit. Finally, in order to assess the zoo "industry standard" for feeding bears in captivity and to compare this to free-ranging bear food habits, a

survey of the diets and feeding procedures in 67 zoos for four bear species was carried out and the results are reported here.

MATERIALS AND METHODS

Animals and Enclosures

Individuals of three bear species were used in these experiments: an 18-year-old, wild-caught, male American black bear, a 13-year-old, captive-born, female brown bear, and a 7-year-old, captive-born, male sloth bear. During the experiments, all bears were singly housed in concrete enclosures consisting of a rock wall on one side and a 4 m deep moat on the other side that separated the animals from the public. Each bear had access to one or two holding areas where it was normally fed. The yards varied in area: sloth bear, 100 m^2; black bear, 67 m^2; brown bear, 210 m^2. Each contained a pool (approx. 8,000 liters) for drinking and swimming. Sloth and brown bear yards were furnished with several large logs approximately 6 m in length, bolted to the ground. The black bear exhibit contained a wooden denning hut also bolted down. There were no other manipulatable furnishings in the enclosures prior to the experiments.

Materials

Honey-filled spruce logs used in experiments 1 and 2 were approximately 125 cm × 20 cm, and were designed and manufactured by Mark Baldwin (Box 407, Surrey, Maine 04684). Sets of 3 holes, 3 cm wide, were drilled around the circumference of the log so that they met in the center, forming a three-armed well. Each log contained 6 such wells. Before presentation to a bear, the wells were filled with approximately 100 g of honey, then plugged tightly with 4 cm lengths of wooden dowels for a total of 18 access plugs. A bear could obtain the honey by digging out around the plugs with its claws, then pulling them with its teeth.

EXPERIMENT 1: PROCEDURE

To examine the behavioral effects of giving bears food-containing, manipulatable objects, honey-filled logs were introduced into the sloth and black bear exhibits according to the following procedures.

Pre-Test (n = 6 Days)

Behavior was observed for 6 consecutive days before introducing the first honey-log.

Test 1 (n = 5–6 Days)

A freshly filled honey-log (#1) was placed in each yard, anchored to a ground bolt with a 1.5 m length of chain so that it would remain manipulatable but not roll into the moat. Logs were presented at 9:30 A.M. and removed at 3:30 P.M. for 2 consecutive days, then left in the yards continually for 3 or 4 more days starting on day 3. Honey was refilled on day 3 or 4.

Test 2, (Sloth Bear Only, n = 4 Days)

Two days after removal of log 1, a new freshly filled honey-log (#2) was again placed in the sloth bear yard for 4 continuous days.

Post-Test, (Sloth Bear Only, n = 5 Days)

A 5-day post-test observation period without a log was conducted following removal of log 2.

Test 3, (Sloth Bear Only, n = 5 Days)

Immediately following the post-test period, another new honey-log (#3) was placed in the sloth bear yard for 5 continuous days. Honey was refilled on day 4.

Behavioral observations were made throughout all periods of the experiment via a video camera above the enclosure. Hours of observation were from 9:30 A.M. to 3:30 P.M. for the sloth bear, and from 6:00 A.M. to 6:30 P.M. for the black bear. Total minutes per day spent in the following behaviors were scored from the video tapes: Time Manipulating Log: Exploration/Foraging (defined as standing or walking with nose oriented toward the ground or an object); Total Time Active in Exhibit; Walking and Pacing. The latter was stereotypic in the black bear, but in the sloth bear; although pacing occurred in one area of the yard, it was not sufficiently fixed in form to be considered stereotypic. Because both Walking and Pacing were not obviously goal-oriented, they were combined as one behavior category for the sloth bear. Differences between the total amounts of behavior on the days in each of the five observation periods for the sloth bear were analyzed using a Kruskal-Wallis one-way analysis of variance, [Siegel, 1956] with multiple post-hoc comparisons [Dunn, 1964, in Hollander and Wolf, 1973]. Behavioral differences between the pre-test days and test 1 days in the black bear were analyzed using a Mann-Whitney U-Test [Siegel, 1956].

EXPERIMENT 1: RESULTS AND DISCUSSION

The amount of time the sloth and black bears spent manipulating honey-logs introduced into their exhibits is illustrated in Figure 1. The first new, honey-filled log (#1) was manipulated on day 1 for over 2 hr by the sloth bear (Fig. 1a) and for 38 min by the black bear (Fig. 1b). On subsequent days, considerable decreases in log 1 manipulation time were observed, unless the log was refilled with honey, in which case the time increased to day 1 levels in the sloth bear (day 3 in Fig. 1a), although not in the black bear (day 4 in Fig. 1b). For the sloth bear, presentation of logs 2 and 3 resulted in similar patterns of habituation across the 4 or 5 days the log was in the exhibit. Logs 2 and 3 did not elicit as much manipulation on days 1–3 as the first log, in part because the bear had become more adept at removing the honey.

The effects of log presentations on the behavior of the sloth bear are shown in Figure 2. Honey-logs had significant effects on Walking/Pacing ($H = 9.45$, $P < .05$) and Exploration/Foraging ($H = 10.41$, $P < .05$, Fig. 2). The first and second honey-logs significantly decreased Walking/Pacing when compared to the pre-test period before log presentation, but by the time log 3 was presented these effects were no longer significant. Thus, while all logs elicited manipulation activity, only the relatively more novel presentations of the first two logs significantly inhibited walk-

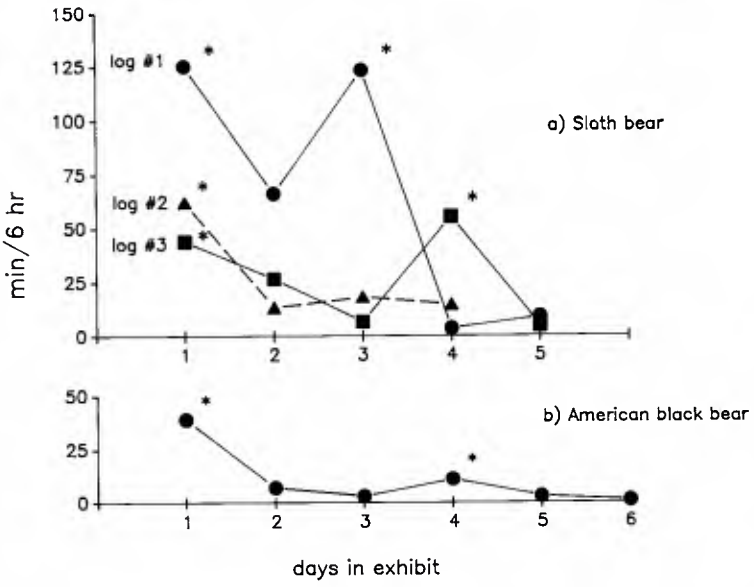

Fig. 1. Median min between 9:30 A.M. and 3:30 P.M. manipulating honey-logs for sloth bear (**a**) and American black bear (**b**). * denotes days on which logs were filled with fresh honey.

ing and pacing. Exploration of the yard also decreased significantly during all three log presentations when compared to the pre-test period, but not to the post-test period (with the exception of log 1). Differences in total activity were non-significant. Presentation of a honey-log to the black bear produced no significant changes in locomotory (pre-test/test 1, median min/day Pacing: 111/144, n = 6,6, U = 9, $P >$ .05; Walking: 12/19, U = 16, $P >$ .05) or exploratory behavior (2/12, U = 14, $P >$ .05).

This experiment demonstrates that habituation to introduced manipulatable objects is both specific and general; for both bear species each log stimulated less activity after its first day in the exhibit, and for the sloth bear there was also decreased activity directed toward new logs introduced subsequently. For the sloth bear, the habituation to a specific log could be overcome by refilling it with honey; the black bear, however, did not respond as much to the addition of honey.

The presence of a manipulatable, food-containing object in the sloth bear exhibit also reduced non-goal-oriented locomotory behaviors. The absence of an increase in total time active when a log was present indicates that the logs were not altering activity levels in general; rather they replaced pacing, walking, and exploration with a functional, goal-directed activity.

EXPERIMENT 2: PROCEDURE

This experiment examines the effects of presenting freshly filled honey-logs on investigation of objects already in the yard by the brown bear. On day 1, the remains of three honey-logs presented 10 or more days earlier were in the exhibit. On days 2, 4, and 6, new, freshly-filled honey-logs were presented, unchained, to the bear at

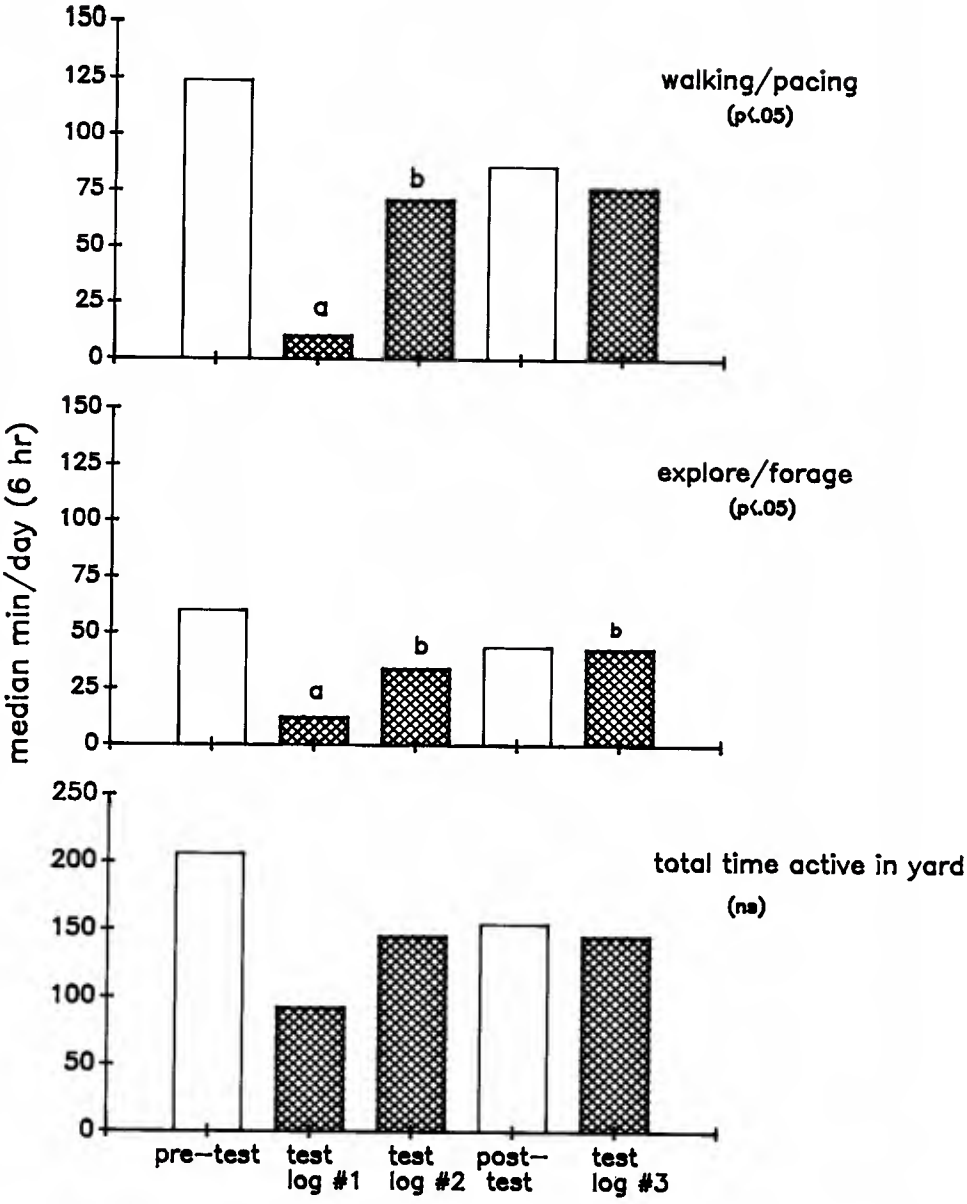

Fig. 2. For the sloth bear, median min per day between 9:30 A.M. and 3:30 P.M. pacing or walking, exploring/foraging, or total time active in yard during each of the 5 periods of experiment 1. Results of post-hoc multiple comparisons are indicated by letters above the bars: a = significantly less than all other periods ($P < .05$), b = significantly less than pre-test period only ($P < .05$).

10:00 A.M. On days 1, 3, and 5, nothing new was introduced. All logs that were introduced were left in the exhibit so that there was a cumulative increase in the number of logs present from three on day 1 to six on day 6. Daily total time spent manipulating old and new logs between 10:00 A.M. and 4:00 P.M. on days 1–6 was recorded by observers sitting in front of the exhibit.

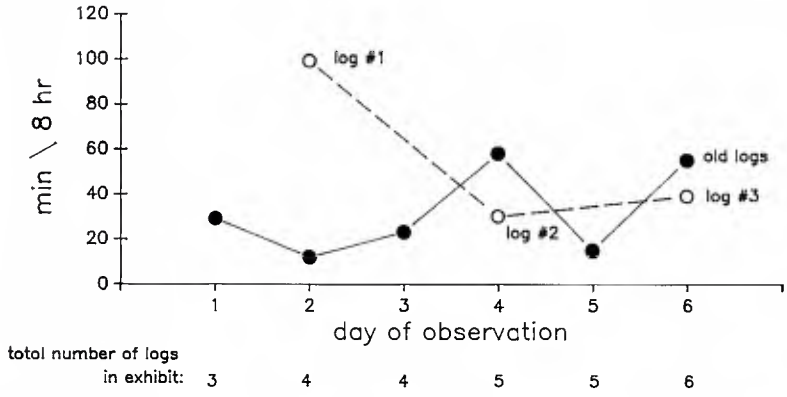

Fig. 3. Daily honey-log manipulation time from 10:00 A.M. to 4:00 P.M. for a brown bear for the 6 days of experiment 2. Open circles are the times new, freshly-filled logs were manipulated on the day they were introduced; solid circles are manipulation times for old logs in the yard.

EXPERIMENT 2: RESULTS AND DISCUSSION

The time spent manipulating new, honey-filled logs (#1, 2, and 3) on days 2, 4, and 6 are given in Figure 3. When the first new log was introduced, it was handled by the bear for 100 min. Subsequent new logs were manipulated only 30–40 min, indicating a habituation to new logs in general, as found in experiment 1. However, the decline in activity directed toward new logs 2 and 3 is counteracted by an increase in activity directed toward old logs already in the exhibit (days 4 and 6). They were manipulated at 2–3 times the rate (60 min) as on days 1, 3, and 5 when no new log was given (20–25 min, Fig. 3).

Thus, investigation of old objects that at one time contained food is stimulated by new, food-containing objects. This experiment demonstrates the utility of maintaining multiple objects in a bear exhibit to counteract general habituation to newly introduced objects.

EXPERIMENT 3: PROCEDURE

Three methods of feeding the American black bear were examined in this experiment.

Standard Method

Food was placed on the floor of the holding area at approximately 9:00 A.M., the bear was locked in, and the outside yard was cleaned. At this time the black bear received 0.25–0.5 kg (depending on the season) of Nebraska Brand feline diet, 700 g Spectrum omnivore chow, 2–6 apples, oranges and carrots, and one loaf of bread. At approximately 2:00 P.M. the bear was sometimes also given snacks of raisins, fruit, peanuts, or additional omnivore chow.

Feeder Method

The black bear yard contained a "feeder tree" (manufactured in house) constructed of gunnite and containing 16 cups on a rotating plate. An air compressor

drove a mechanism that rotated the plate and released food snacks contained in the cups according to preset times controlled by a clock. A well containing honey was also opened and shut by this mechanism. Snacks and honey were randomly released at six different dispensing locations at the base of the tree or 1.5 m up the trunk. The Feeder Method consisted of the standard morning feeding as described above plus 100 g raisins, 200 g peanuts, and 250 g honey, dispensed over 6 times at variable intervals between 8:00 A.M. and 4:00 P.M. daily.

Food-Hiding Method

This method consisted of taking the standard portions of food, except for the meat, and hiding them throughout the exhibit. At approximately 9:00 A.M. the bear was shifted into the holding area where he was given the meat while the experimenter "loaded" the exhibit yard. This took approximately 20 min. The yard was furnished with a number of hollow logs in which fruit, bread and omnivore chow were concealed. These foods were also placed under stones and logs and in rock crevices. Raisins (100 g) and peanuts (100 g) were mixed with hay contained in a wooden denning hut. A 30 cm "Boomer Ball" (P.O. Box 83, Gray's Lake, IL 60030), drilled with numerous 1 cm holes and secured with a 1 m length of chain, was filled with shelled peanuts through a lid in the top of the ball. Honey was poured on rocks or in the holes of old honey-logs from experiment 1. These holes were also stuffed with a few raisins and loosely replugged.

Feeding experiments were carried out in the last week of October and the first 2 weeks of November in 1987 and 1988. In 1987, 4 consecutive days of Standard Feeding were followed by 6 days of the Feeder Method and 3 more days of Standard Feeding. In 1988, exhibit furnishings for hiding food had been placed in the enclosure. These were left empty for 5 days of Standard Feeding, and thereafter filled daily for 8 days of Food-Hiding, followed by another 3 days of Standard Feeding.

Behavioral observations were carried out via time-lapse video recordings made from 6:00 A.M. to 6:00 P.M. Daily total time spent in the following behaviors were quantified from the video tapes: Walking; Stereotypic Pacing (see results for description); Exploring/Foraging (as in experiment 1); and Total Time Active in Yard. Differences among behaviors on the days when either the Feeder Method (6 days) or the Food-Hiding Method (8 days) was employed were compared to the days in, respectively, 1987 (7 days) or 1988 (8 days) during which feeding was Standard, and were tested for significance with Mann-Whitney U-Tests.

EXPERIMENT 3: RESULTS AND DISCUSSION

The American black bear exhibited a severe stereotypy: he paced back and forth along the front edge of the enclosure in front of the pool in a very fixed manner, 18 steps each way, for up to 8 hr/day in the late spring breeding season, and up to 4 hr/day in the summer and fall. For most of the year pacing was most prominent for several hours before and just after feeding time [Carlstead and Seidensticker, in prep.].

For each method of feeding, Figure 4 gives the median total min of the daily 12-hr observation periods spent in each of the four behavior categories. No significant differences were found in any behaviors between feeding by the Standard Method and the Feeder Method, except for an increase in Exploring/Foraging when the feeder tree

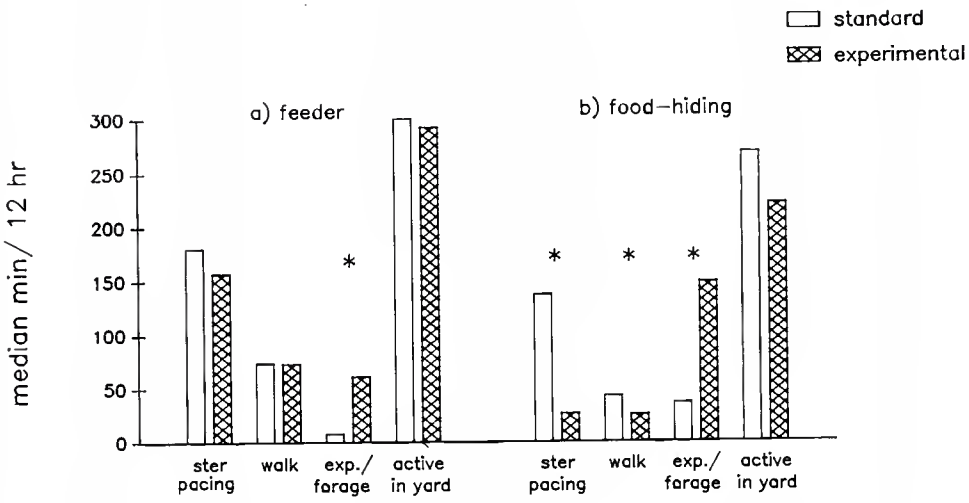

Fig. 4. Median min per day between 6:00 A.M. to 6:00 P.M. of stereotypic pacing, walking, exploring/ foraging, and total time active in yard for an American black bear when fed following the Standard Method and experimental Feeder Method (a) or Food-Hiding Method (b). *$P < .05$.

was dispensing food (U = 2, n = 6,7, $P < .002$, Fig. 4a). However, hiding the same amount of food throughout the exhibit significantly reduced Stereotypic Pacing from 125 min/day under Standard conditions to a median of 20 min/day (U = 10, n = 8,8, $P < .02$). Walking around the exhibit was also significantly reduced (U = 10.5, $P < .028$), and Exploring/Foraging was significantly increased (U = 13, $P < .05$). Total Time in the Yard did not differ between Standard or either experimental condition. Upon being released from the holding area to begin feeding in the "loaded" exhibit, the bear usually went directly for the Boomer ball filled with peanuts. To obtain them he pushed the ball with his nose so that it rolled around and peanuts dropped out. This activity occupied him for up to 20 min until the peanut supply was depleted. The bear generally consumed all the food in the yard in a feeding bout of approximately 90 min that began when he was released into the yard, and in several shorter foraging bouts interspersed throughout the rest of the day.

Hiding food in manipulatable exhibit furnishings thus caused an increase in foraging behavior that appears to have replaced stereotypic pacing in the black bear. In constrast, the increased foraging behavior elicited by the automatic feeder was ineffective in reducing stereotypic behavior.

BEAR DIET SURVEY

A questionnaire was sent to 82 zoos known to exhibit black (American or Asian, *Ursus thibetanus*), brown, or sloth bears. Each zoo was asked to list the items fed to these bears, the amount, and the manner in which it was delivered.

Sixty-seven zoos (79%) responded to the bear diet questionaire. The respondents included 43 zoos exhibiting American or Asian black bears, 36 with European or North American brown bears, and 16 with sloth bears. Fifty different food items were listed, but in general the staples varied little from zoo to zoo and a few items

predominated. The variability in diet occurred primarily in supplemental snacks and in fruits and vegetables with different seasonal availability. The average diet consisted of 5.5 different food items, with a low of one (commercial omnivore diet only) and a high of 18. The diets of all four species are similar, with high-protein, commercially prepared food constituting the major portion of the diet; this is supplemented with meat, fish, fruits, and vegetables. Omnivore diet is the most commonly fed item (58% of respondents). Other important protein sources are dog food (36%), fish (57%), and raw meat (45%). Fruits (89%) and vegetables (58%) are the other main component of captive diets; apples and carrots are by far the most commonly fed item in this food group. Breads and grains are also significant in some diets, especially for sloth bears.

The methods of feeding the diets varied little among zoos. A high proportion (83%) of the zoos responding to the survey feed their bears once per day, equally often in the holding area or on exhibit. Food is mostly piled when fed in the holding area and mostly scattered around if feeding is in the exhibit. Only 8 of 67 zoos feed in the manner most time-consuming for bears: scattering food throughout the exhibit up to 3 times daily. Many of the respondents feed their bears once daily, with "occasional snacks and treats," but there was little further elaboration on how these are given. One respondent mentioned that apples were thrown in the pool for the bears to retrieve, and another said that honey was poured in the cracks of logs for sloth bears.

The "industry standard" diet of zoo bears does not generally mimic the diet of bears in the wild; rather, captive bear diets seem to be rooted in what has traditionally been convenient and economical. Black, brown, and sloth bears are specifically adapted to living on small items high in nutrients and low in cellulose. They have omnivorous food habits and unspecialized digestive systems. Field studies of the natural food habits of free-ranging bears reveal that there are 1) dramatic seasonal shifts in diet that are determined by the availability of plants and to some extent animal prey, and 2) a large variety of food types are consumed [Craighead and Sumner, 1982; Eagle and Pelton, 1983; Graber and White, 1983]. In particular, the reproductive parts of plants (fruits, nuts, berries, acorns) and colonial insects comprise a large portion of black and brown bear diets [Craighead and Mitchel, 1982; Eagle and Pelton, 1983; Graber and White, 1983; Mace and Jonkel, 1986]. Sloth bears are largely insect (mainly termite and ant) and fruit eaters; at least 17 different fruit species have been identified as sloth bear foods [Laurie and Seidensticker, 1977].

GENERAL DISCUSSION

These 3 experiments demonstrate that behavioral improvements in zoo bears can be achieved by requiring them to manipulate objects to acquire food. Experiments 1 and 2 demonstrated that obtaining food from an introduced, manipulatable object overcomes specific and general habituation to the object, and in experiments 1 and 3, retrieving food concealed in manipulatable objects substantially reduced stereotypic behavior. These results provide evidence that environmental stimuli that elicit appetitive behavior (i.e., investigation, search, object manipulation) are essential for guiding feeding-motivation into functional foraging behavior sequences. Foraging behavior is strongly controlled by the stimuli in an animal's environment. While searching

for food there is an interdependency between the stimuli an animal encounters in its environment and the behavior it performs to modify these stimuli. The animal thus develops contingencies between its behavior and the consequences of its behavior. Feeding bears in multiple daily meals or outfitting enclosures with feeding devices that dispense snacks at unpredictable intervals recognizes the high motivation of bears to feed, but for the bear these means of acquiring food are not behavior-contingent. The dispensed food is merely retrieved from a highly predictable location. The diverse, complex foraging behaviors the bear has available to it cannot be used under these conditions to modify its environment. These circumstances, coupled with a high motivation to forage or feed, are theorized to cause stereotypy development in other species [Keiper, 1969; Falk, 1971; Rushen, 1984].

Bears easily develop begging habits in zoos when fed by the public, and it is interesting to note that van Keulen-Kromhout [1978] in her survey of zoo bears, found that bears that beg tended to exhibit less stereotyped pacing than non-begging animals. Begging is thus another behavior-contingent appetitive activity that appears to effectively reduce or prevent the development of stereotypies. However, it is far more desirable from a naturalistic perspective to exhibit a bear that forages for hidden food than one that begs for food from humans.

The behavior patterns involved in foraging are complex in free-ranging bears, and each of the three species of this study has unique behavioral adaptations for acquiring food. Black bears use the forepaws and claws for digging, raking, debarking trees, lifting and turning over objects, or for delivering a killing slap to small animals or insects. They also use the tongue and teeth to delicately remove edible plant parts [Bacon, 1976]. Brown bears dig extensively for roots, corms, and tubers by using both forepaws or by plowing with their noses, and they hunt small mammals by excavating and chasing them [Mealey, 1977; Stelmock and Dean, 1986]. They are able to capture spawning fish with their teeth and long claws. Sloth bears possess large claws that are used for digging and tearing open logs or termite mounds, and for climbing fruit and honeycomb-bearing trees. The protrusible, mobile lips and snout of the sloth bear are adapted for feeding on insects by blowing and sucking into their colonies [Laurie and Seidensticker, 1977].

The main problem with the current status of captive bear behavior lies in the traditional manner of feeding bears in zoological parks. The overwhelming difference between captive and wild bear feeding habits is in the acquisition and handling of food. In the wild, most bear foods are small, particulate, numerous, and patchily distributed, requiring extensive time to collect and to consume in sufficient quantities, and as mentioned previously, free-ranging bears do just that. In captivity, foods are delivered in large, concentrated portions that are ingested in minimal time with the most simple of feeding behaviors. The present experiments suggest that foraging behaviors in captive bears can be maximally stimulated by providing multiple exhibit furnishings that are 1) manipulatable, 2) able to conceal food, and 3) as novel as possible. An introduction schedule of a number of different, novel, food-containing objects, in combination with more permanent manipulatable exhibit furnishings in which small, particulate food can be hidden, could be beneficial to zoo bear behavior without requiring excessive innovation and time expenditure of keepers.

The behavioral effects of honey-log presentation and food-hiding reported here are only short-term and based on a sample size of three bears. In the long-term, habituation to introduced objects might be expected to be more complete unless some

attempt is made to vary the objects and foods that are introduced. However, behavioral observations were carried out on the American black bear over a 5-month period in which the Food-Hiding Method was employed for more than a week each month [Carlstead and Seidensticker, in prep.]. There were no indications of habituation to the hiding places or decreased effectiveness in reducing stereotypic behavior.

Hediger has many times emphasized the need to recognize the "psychological" aspects of feeding zoo animals, and has pointed out that a lack of occupation can result in abnormal stereotyped behavior [1950, 1966, 1970]. This is particularly relevant for opportunistic feeders, such as bears, that by nature are always investigating and testing their environment [Morris, 1964]. The experiments presented in this paper indicate that providing occupational opportunities for bears that allow them to actively acquire frequent and small amounts of food can go a long way toward improving the exhibition and welfare of zoo bears.

CONCLUSIONS

1. Habituation to a food-containing object, a honey-filled log, introduced into a bear enclosure is both specific to a given log and general to subsequent logs. Refilling a log with honey after it has been in the exhibit for several days restimulates manipulation activity back to day 1 levels. Providing multiple manipulatable objects compensates for the general habituation to new logs.
2. In a sloth bear, the manipulation activity elicited by a novel, food-containing object replaced non-goal-oriented locomotory behavior.
3. Being able to search for and collect food that is hidden throughout the exhibit in manipulatable furnishings considerably reduced Stereotypic Pacing in an American black bear. Feeding from an automatic feeder device failed to do so.
4. The "industry-standard" diet and method of feeding captive bears does little to stimulate time-consuming food-searching and food-handling behaviors, and probably is the reason for the high incidence of stereotypy in captive bears.

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