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Seasonal variation in stereotypic pacing in an American black bear *Ursus americanus*

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Abstract

The behaviour of a male American black bear *Ursus americanus* was observed for over 2400 h across all seasons of the year. Stereotypic pacing was most frequent, oriented away from the exhibit, and performed mainly after feeding during the period May–July; from August–November pacing was oriented towards the exhibit and performed mainly around feeding time. Placing bear odors in the enclosure slightly reduced pacing and increased exploring/foraging in the late spring. Hiding small food items in the exhibit almost completely eliminated pacing in the fall and replaced it with foraging. Comparison with seasonal changes in the behaviour of wild bears suggest that the stereotypy of this bear, and probably zoo bears in general, developed from two main primary behaviours that cannot be performed in a barren zoo environment: mate-seeking behaviour predominating in the late spring and foraging behaviour in the late summer and fall.

Introduction

Stereotypy is a common problem in zoo-housed bears (Holzapfel, 1938; Boorer, 1872; van Keulen-Kromhout, 1978; Horseman, 1986) in spite of a trend in modern zoos towards naturalistic exhibits. Space restriction, improper exhibit design and/or boredom are offered as causes (Hediger, 1950; Boorer, 1972; Law & Boyle, 1986; Stevenson, 1983), but there have been virtually no quantitative studies on stereotypy in non-primate zoo animals since the Meyer-Holzapfel studies (1968; Holzapfel, 1938, 1939). Stereotypy may be the idiosyncratic expression of some primary behaviour that is prevented from being functionally completed by confinement in an unstimulating environment. The National Zoological

Park exhibited an American black bear *Ursus americanus* with a consistent and frequent pacing stereotypy. It consisted of 15 steps in one direction and a 3-point turn to reverse, performed repetitively along a ledge at the front of the exhibit. A back and forth cycle took 19–24 s to complete, in bouts of 1–90 min.

The purpose of this investigation is to develop an hypothesis on the causation of stereotypic pacing in zoo bears through a detailed analysis of variation in this one individual's pacing behaviour in relation to seasonal and physical changes in his external environment. Observational and experimental evidence, based on 2400 h of video recordings, is provided in support of the hypothesis that there are two main source behaviours of pacing occurring predominantly at different times of the year: mate-seeking behaviour during the late spring/early summer months, and foraging in the late summer and fall.

Materials and Methods

The 18-year old, wild-caught male American black bear ("Smokey"), was housed in a 68 m², oval-shaped, concrete and rock, dry-moated enclosure at the National Zoological Park since he was 18 months old. The enclosure contained an oval-shaped pool (3.7 m × 2.4 m × 1.5 m), a wooden denning hut (1.2 m × 1.8 m × 1 m) filled with straw, 2–6 hollowed out logs (± 1 m in length), several large, loose stones, a 12 m² holding area, and an inoperable gunnite food dispenser tree. Every morning at approximately 0930 h the bear was normally fed in the holding area a diet of 0.25 – 0.5 kg of Nebraska Brand feline diet, 700 g Spectrum omnivore chow, 2–6 apples and oranges, and one loaf of bread. Snacks of raisins, fruit, peanuts, or additional omnivore chow were given in the afternoon in the holding area.

Behavioural observations

All observations were carried out via a low-light CCTV video camera and time-lapse recorder, except in 1990 when direct observations were made by volunteers. Time of day and duration of the following behaviours were registered: stereotypic pacing, walking around, exploring/foraging (walking or standing with nose to the ground), resting or sleeping, rubbing body against wall, in moat, in holding area. For a given bout of pacing the predominant direction of the turns was also noted.

There were 3 conditions under which the bear's behaviour was observed for an entire day: (1) "control" days with normal husbandry procedures, (2) "food-hiding" days when, at 0930 h, the non-meat portion of the diet was scattered or concealed throughout the exhibit under objects and mixed in with straw, and (3) "bear odor" days when, at 0930 h, objects permeated with a bear scent where placed at various points in the exhibit. The odors consisted of: anal gland secretions from a male panda *Ailuropoda melanoleuca*, logs previously chewed on by a female brown bear, spectacled bears *Tremarctos ornatus*, and a male sloth bear *Melursus ursinus*. scats from wild black bears, hair clippings and vulval rubbings on a paper towel from a wild female black bear, sloth bear hair, sign posts chewed on and marked by wild black bears, and commercially available hunting lures reputed to be made of male or female black bear urine (Robbins Scents, Connellsville, PA,

TABLE 1

Sequences of behaviour observations.

Year	Observation period	h/day	Number, type and order of observation days (c, control; fh, food-hiding; bo, bear odor days) *
1987	Apr–Nov	24	9c/month
1988	May–Jul 15	13	6c–8fh–3c–11bo
	Aug–Nov	13	4fh–7c–10fh–3c–13fh 9c–7fh–8c
1990	May–Jun	13	8c–8fh–3c–8bo

* Days of no observations and normal husbandry procedures were interspersed within and between c, sc, and bo conditions throughout a given observation period.

USA). Each day a scent different from that used the previous day was placed in the exhibit, although several of the odors were used more than once.

Observations were carried out in the sequences described in Table 1. Comparisons of daily behaviour frequencies between the months of 1987 and between food-hiding, bear odor and control days were carried out using Mann Whitney U-tests or Kruskal–Wallis one-way analysis of variance with post-hoc multiple comparisons (Dunn, 1964, in Hollander & Wolfe, 1973).

Results

The bear was only active from April to mid December; during the winter months he denned in the wooden hut or holding area. In the summer of 1987 the bear was never observed to be active past 2200 h; generally he settled in to sleep at dusk throughout the year. A significant pattern of seasonal variation in the frequency and morphology of stereotypic pacing was found. The mean number of minutes/day spent pacing from April to November, 1987 is given in Fig. 1. Pacing frequency is significantly higher in May and June than in other months ($H = 29.77$, $N = 72$ days, $p < 0.0001$; May > Apr, Aug, Sep,

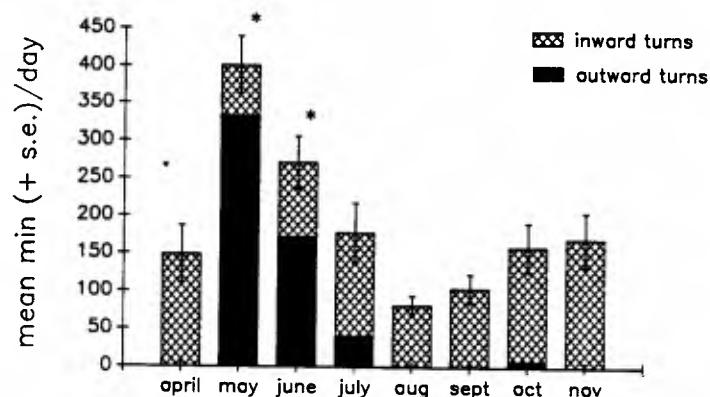


Fig. 1. Mean minutes/day spent pacing during the months the bear was not denning. Inward and outward turns refer to the orientation of the movement pattern with respect to the exhibit as direction is reversed. Asterisk = $p < 0.05$ for post-hoc comparisons (see text).

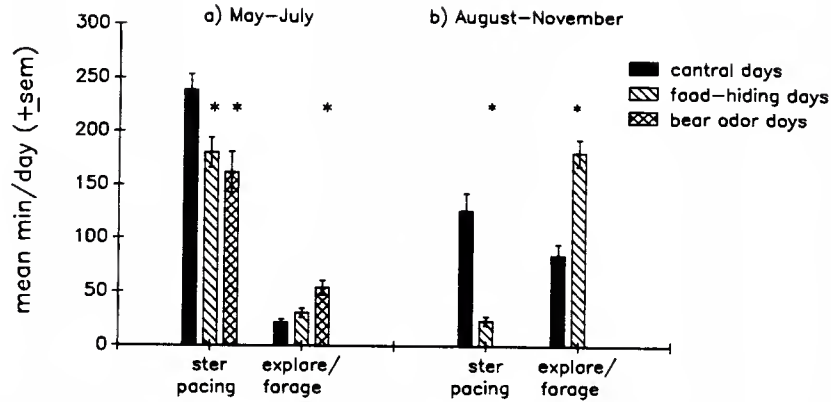


Fig. 2. Mean minutes/hour spent pacing in the a) late spring or b) late summer/fall on control, food-hiding, and bear odor days. Asterisk indicates significant differences in post-hoc comparisons (a) or Mann-Whitney U-test (b).

Oct; Jun > Apr, Aug, Sep). These are the only months in which the bear was observed to rub his body against the rock wall of his enclosure. Bouts of pacing in May, June and July were on average twice as long as bouts the rest of the year (May-Jul mean min/bout \pm sem = 15.4 ± 0.48 , Aug-Nov = 7.26 ± 0.16). In addition, pacing was found to occur in two principal forms. The bear could reverse his direction of movement by turning either inwards towards the exhibit yard and keeper area, or outwards towards the neighboring female brown bear exhibit, the public viewing area, and a forested area beyond. The proportion of the time spent pacing in which the turns were outward was high in May, June and the first half of July, but at other times of year turns were mostly inwards (Fig. 1). Finally, during the period May-July, pacing occurred mostly after feeding time in the afternoon and evening hours, whereas from August to November, pacing was most frequent in the morning before feeding time.

During the period May-July (1988 and 1990) both providing novel bear odors and hiding food in the yard slightly but significantly reduced stereotypic pacing, as compared to control days ($H = 9.48$, $N = 55$, $p < 0.008$; food-hiding days > control days; bear odor days > control days, Fig. 2a). Exploring/foraging was significantly increased on bear odor days as compared to control and food hiding days ($H = 17.7$, $p < 0.0001$, Fig. 2a). In the period August-November (1988), scattering and hiding food throughout the yard practically eliminated stereotypic pacing ($U = 23.5$, $n = 34, 27$, $p < 0.0001$, Fig. 2b). Exploring/Foraging was significantly increased ($U = 34.5$, $p < 0.0001$, Fig. 2b). Analysis of the temporal pattern of pacing and foraging indicated that foraging occurred in place of pacing throughout the day even though most of the food was retrieved in the first two hours after food was hidden in the yard. Furthermore, after 34 days of hiding food in essentially the same place over a 4 month period, the stereotypy-reducing effect was not in the least diminished, indicating that the novelty of finding food in the yard was probably not the cause of this effect.

Discussion

The behaviour of this American black bear is highly dependent on the time of year, as is the case for wild black bears. The primary behaviours for stereotypic pacing may be

inferred by comparison with the seasonal habits of free-ranging bears. The physiology and behaviour of black bears is highly adapted to a seasonally changing food supply. Black bears den in the winter when food is not available. The breeding season is in June and July, at which time males travel through their home ranges, associating with females for from a few hours up to 5 days, and interacting with competing males (Barber and Lindzey, 1986). They mark trees with their claws or rub them with their bodies, perhaps as olfactory signals to other bears (Rogers, 1977; Burst and Pelton, 1983), and serum testosterone levels are elevated (Palmer et al., 1988). In the later summer and fall when food is abundant, black bears become obese because of hyperphagia, acquiring the energy reserves required for denning through the winter. Black bear foods are small, particulate, numerous and patchily distributed, requiring extensive time to collect and to consume; they spend up to 18 hr/day foraging for insects, roots, corms, fruit and small animal prey (Eagle and Pelton, 1983).

For the National Zoo's black bear, the high frequency of post-feeding stereotypy during the natural breeding season of wild bears, coupled with an orientation outwards from the exhibit, provides support for the hypothesis that the primary behaviour of pacing May–July is home-range patrolling for social signals from potential mates or competitors. Providing odors from other bears in the exhibit reduced stereotypy and increased exploration of the yard. Olfactory stimuli are thus sufficient to distract the bear from pacing during the breeding season, possibly because they are appropriate releasing stimuli for the primary behaviour of the stereotypy. On the other hand, the novelty of the smells may also account for the distraction from pacing. Unfortunately, the effects of bear odors outside of the breeding season could not be investigated, as planned for the fall of 1990, due to the death of the bear.

In the late summer and fall period, stereotypy performed around feeding time and orientation towards the direction from which the keeper approaches to feed, leads to the conclusion that the primary behaviour the bear is prevented from performing is foraging. Providing the opportunity to manipulate objects to retrieve numerous small food items in the enclosure almost eliminated pacing and replaced it with foraging behaviour, indicating that the stereotypy was not emancipated from its original causal factors. A stereotypy-reducing effect of food-hiding was also observed during the breeding season, but without a concomitant increase in exploring/foraging. In other bear species, frequent and varied feeding schemes in which the bears had to retrieve food or beg for it have also been anecdotally reported to reduce or be negatively correlated with stereotypy (polar bears *Ursus arctos*; Markowitz, 1978; Law & Boyle, 1986; van Keulen Kromhout, 1978). In an earlier experiment, it was shown that food snacks delivered automatically 6 times/day from a mechanical feeder device requiring no object manipulation for food retrieval, did not reduce this bear's pacing behaviour in the fall (Carlstead et al., 1991). Evidence for a behavioural need or preference to perform foraging and feeding behaviours has been reported in a number of different species (racoons, pigs, chickens, Breland and Breland, 1961; rats Carder and Berkowitz, 1970; rats and humans, Singh, 1970), and this has led to the observation that appetitive behaviours in some species may be self-reinforcing (Wiepkema, 1985; Dantzer, 1986; Hughes and Duncan, 1989). When the environment does not allow the appropriate functional consequences to be associated with the appetitive behaviour, the latter becomes internally controlled, repetitive and persistent. Bears represent, perhaps, an extreme example of an animal "hardwired" to forage because of their large energy needs and seasonally variable food sources. In many captive environments with only one daily feeding of concentrated foods, the behavioural need to forage

goes unmet and thus the high incidence of stereotypies in zoo bears (Carlstead et al., 1991). In such cases feeding methodology should be changed and exhibit spaces enriched with manipulatable objects and substrate for hiding food.

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