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Behavior of Giant Pandas (*Ailuropoda melanoleuca*) in Captive Conditions: Gender Differences and Enclosure Effects

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The behavior of giant pandas (*Ailuropoda melanoleuca*) was studied under captive conditions. Both male and female pandas spent similar amounts of time engaged in eating and locomotion. Males performed anogenital-marking more but rested less than females, which suggests a sexually dimorphic pattern of behavior. Furthermore, females housed in the seminatural environment spent significantly less time engaged in stereotyped behavior than did females housed in the traditional enclosure, indicating that an enclosure environment affects the behavior of giant pandas. These data illustrate the importance of careful management and facility design for captive giant pandas. Zoo Biol 22:77–82, 2003. © 2003 Wiley-Liss, Inc.

Key words: seminatural enclosure; stereotyped behavior; sexual dimorphism

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INTRODUCTION

The behavior of giant pandas (*Ailuropoda melanoleuca*) in captive conditions has been described in several studies [Kleiman, 1983; Nakazato et al., 1985; de Bois et al., 1990; Wang et al., 1990; Mainka and Zhang, 1994; Liu, 1996; Liu et al., 1998]. Both male and female pandas show similar peaks in daily activity associated with feeding. In addition, a sexually dimorphic pattern was found: male pandas spend more time on eating, anogenital marking, and locomotion, but less time on sleeping, in comparison with females [Mainka and Zhang, 1994; Liu et al., 2002]. These previous studies were conducted on subjects that were housed in traditional captive enclosures. Because behavior is the product of gene–environment interactions, an animal's physical environment may have significant impacts on its behavior [Kreger et al., 1998]. For example, hand-reared sloth bears (*Ursus ursinus*) perform stereotyped and self-directed behaviors more frequently than do mother-reared sloth bears [Forthman and Bakeman, 1992]. Meadow voles (*Microtus pennsylvanicus*) housed in a large enclosure show more paternal attendance compared to their conspecifics housed in a standard mouse cage [Storey and Snow, 1987]. It is still unknown, however, whether the enclosure environment influences the giant panda's behavior.

In the present study, we compared female giant pandas that were housed in either a traditional (small) enclosure or a seminatural environment to examine the effects of enclosure environment on the giant panda's behavior. In addition, we systematically examined a variety of behaviors of the male and female giant pandas in the traditional housing condition. The data from the present study should contribute to a better understanding of environment–behavior interactions, and illustrate the importance of careful management and facility design for captive giant pandas.

MATERIAL AND METHODS

Subjects

The subjects were giant pandas (*A. melanoleuca*) (Table 1) housed at the China Conservation and Research Center for the Giant Panda, Wolong Nature Reserve, Sichuan Province, China.

Enclosure Environment

Subjects were housed in two different kinds of enclosure environments. Three males and three females were housed individually in the traditional enclosure containing a night pen (5.8×2.3 m), an outdoor yard (5.8×13 m) with grass, climbing apparatuses, and a small pond as the water source. Each outdoor enclosure adjoined two others via a cement wall in which there was a small wire mesh fence door (1×1 m). Therefore, subjects could see, smell, hear, and even have some limited physical contact through the mesh fence with neighboring animals (individuals of the opposite sex). Four additional females were housed individually in the seminatural enclosure containing a night pen (4×3 m) and an outdoor yard (approximately 50×120 m) that stretched along a mountain slope (approximately 35–40°) with pine trees, shrubs, herbs, bamboo (*Fargesia robusta*), and a small pond. Seminatural enclosures were separated by cement walls, over which animals could

TABLE 1. Inventory of giant pandas used in the study

Enclosure	ID[a]	Sex	Birth
Traditional enclosure	Lin Lin (455)	M	1997
	Tian Tian (458)	M	1997
	Jin Zhu (437)	M	1996
	#20 (414)	F	1990
	Ying Ying (382)	F	1991
	Gong Zhu (477)	F	1998
Semi-natural enclosure	Qian Qian (476)	F	1998
	Mei Xiang (473)	F	1998
	You You (474)	F	1998
	#28 (444)	F	1988

[a]Studbook numbers in parentheses.

hear and even see neighboring animals in certain areas of the exhibit. All subjects had been housed in their respective environment for about 1 year before the behavioral observations were begun. The management regimes for the giant pandas were described previously [Swaisgood et al., 1999; Liu et al., 1998, 2002].

Behavioral Observations, Recording, and Analysis

The time spent by the giant pandas on the following behaviors was recorded: anogenital marking (rubbing the anogenital area around or up and down on the surface of an object or on the wall); eating (handling and eating steamed bread, apples, and grass, and drinking water and milk); exploring (investigating an object with a distance of 0.1 m or more between the nose and the object); sniffing (investigating an object with a distance of <0.1 m between the nose and the object, and with a response of Flehman); grooming (scratching and licking of the pelage); resting (inactivity, awake or asleep); urine marking (urinating while in a squat, leg-cock, handstand, or standing posture on the wall or ground); locomotion (rapidly pacing and moving around the enclosure without placing feet in the same position each time and following the same path); and playing (rolling and somersaulting with manipulation of objects, such as food dishes, bamboo stalks, tree branches, or toys provided by the keeper). We also recorded stereotyped behaviors, including pacing (continuous walking back and forth following the same path); circling (walking following a defined route placing feet in the same position each time); self-mutilation (self-inflicted physical harm, such as biting or chewing the tail or leg, or hitting the head against a wall); head bobbing (standing in one place and continuously moving the head up and down); and standing bipedally at the window of the door or the fence, often seemingly in expectation of food delivery.

The study was conducted from March to May of 2000. Because in previous studies [Mainka and Zhang, 1994; Liu, 1996; Liu et al., 1998, 2002] giant pandas under similar management were more active between 0730–1030 and 1400–1630 hr (feeding time), behavioral observations were conducted during these two time periods. Each observation lasted 30 min by focal sampling, and the duration of each behavior was recorded on data sheets. Each animal was observed at least once per

week for 8 weeks, and every effort was made to conduct observations at the same time for each subject. In some cases, animals were recorded, and videotapes were replayed for quantification of behavior. The percentage of duration for each behavior was computed for each observation and the mean for each individual over 8 weeks was used for data analysis. Behavioral differences between males and females in the traditional enclosure and between females in the two different kinds of enclosures were compared by using the Mann-Whitney U-test. Statistical significance was assessed at $P \leq 0.05$.

RESULTS AND DISCUSSION

Quantitative behavioral measurements for both male and female giant pandas in the traditional enclosure are summarized in Table 2. Both males and females spent relatively large proportions of their time on eating and locomotion. However, sex differences in behavior were found. Males spent significantly more time displaying anogenital marking than did females. In contrast, females rested longer than did males. Males also seemed to spend more time eating than did females, but this difference did not reach statistical significance. In general, these data are in agreement with previous findings concerning the sexually dimorphic patterns of behavior in captive giant pandas [Mainka and Zhang, 1994; Liu et al., 2002]. A significant sex difference in eating was found in a previous experiment [Mainka and Zhang, 1994], but not in the present study. The failure to detect such a difference may be a result of the small sample size or the slight changes in feeding routines.

The effects of the enclosure environment on behaviors were examined by comparing female giant pandas housed in the traditional enclosure vs. those housed in the seminatural enclosure (Table 3). Females in the seminatural enclosure spent large proportions of their time on eating, resting, and locomotion, as did females in the traditional enclosure. However, the enclosure environment indeed altered the giant panda's behavior. Females in the seminatural environment spent less time engaged in stereotyped behavior than did females in the traditional enclosure. In addition, the former appeared to spend more time engaged in playing than did the latter, but this difference did not reach statistical significance. We also performed a

TABLE 2. Behaviors of male and female giant pandas in the traditional enclosure

Behavior	Female (N=3)	Male (N=3)	*P*
Eating	20.65±5.87[a]	35.67±6.84	0.12
Stereotyped behavior	14.57±4.15	7.22±3.35	0.27
Playing	2.78±1.70	2.24±0.84	0.82
Grooming	3.60±1.47	2.06±1.18	0.51
Urine marking	0.54±0.11	0.38±0.19	0.82
Anogenital marking	0.13±0.07	0.85±0.21	0.05
Resting	28.62±8.24	9.04±4.95	0.05
Sniffing	0.42±0.18	0.41±0.35	0.82
Exploring	5.21±1.19	10.79±2.92	0.27
Locomotion	21.33±1.16	29.93±5.59	0.51

[a]Proportion of time±SE.

TABLE 3. Behavioral comparison between females in the semi-natural and traditional enclosures

Behavior	Semi-natural (N=4)	Traditional (N=3)	*P*
Eating	25.34±3.49	20.65±5.87	0.28
Stereotyped behavior	0.09±0.05	14.57±4.15	0.03
Playing	16.26±5.18	2.78±1.70	0.15
Grooming	5.32±1.16	3.60±1.47	0.48
Urine marking	0.58±0.11	0.54±0.11	0.72
Anogenital marking	0.08±0.08	0.13±0.07	0.27
Resting	26.40±5.50	28.62±8.24	1.00
Sniffing	0.76±0.16	0.42±0.18	0.15
Exploring	4.50±0.58	5.21±1.19	0.48
Locomotion	19.22±2.33	21.33±1.16	0.48

correlation analysis and the result indicated that the two behaviors did not show any significant correlation.

To our knowledge, this is the first study to report that the enclosure size significantly influences the behavior of captive giant pandas. These data provide evidence to support the notion that rearing conditions impact an animal's behavior [Kreger et al., 1998]. As all subjects were maintained on the same feeding schedule and provided with the same diet, and the data were collected during the same season, the behavioral differences between the two groups cannot be attributed to these factors. It is interesting to note that in the present study, the effect of the enclosure environment was selective to stereotyped behavior. Although the underlying mechanism and functional significance of stereotyped behavior are still unknown, this behavior has been found in many captive animals [Carlstead, 1998; Gruber et al., 2000] and can be viewed as a form of compensation or adaptation to a restricted, poor environment [Morris, 1964; Carlstead, 1998]. Indeed, an increase in environmental complexity could reduce stereotyped behavior in confined animals [Hediger, 1950; Morris, 1962]. In giant pandas, the occurrence of this behavior is widespread among captive populations [Lindburg et al., 2002]. Furthermore, in a recent experiment, exposure to a range of enrichment items significantly reduced the time that giant pandas engaged in the performance of stereotyped behavior, suggesting that this behavior may be environmentally induced or modulated [Swaisgood et al., 2001]. Our data provide further evidence to support this notion. It should be pointed out that the seminatural enclosure in the present study not only was larger in size, but also had increased levels of environmental complexity by containing pine trees, shrubs, herbs, and some bamboo, in comparison to the traditional enclosure. Therefore, the reduced stereotyped behavior in the seminature environment could result from the increased enclosure size, enhanced environmental complexity, or both. Further experiments are needed to identify the specific environmental factor(s) contributing to the altered behavior.

In conclusion, data from the present study not only further confirmed the previous finding of sexually dimorphic patterns of behavior in giant pandas, but also demonstrated that the seminatural environment can significantly reduce the time that giant pandas engage in stereotyped behavior. Stereotyped behaviors are a pervasive phenomenon usually associated with captive and often suboptimal housing

conditions [Morris, 1964; Lindburg et al., in press]. Although it is still unknown whether these behaviors are deleterious to the animal, the reduction in the level of these behaviors by increased enclosure size and environmental complexity [Swaisgood et al., 2001] (present study) clearly indicates the importance of designing captive facilities to ensure the successful management of giant pandas.

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