



Environmental Enrichments Promote Agility in Captivity for Asiatic Black Bears (*Ursus thibetanus laniger*)

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ABSTRACT

Asiatic black bears (*Ursus thibetanus laniger*) are natural inhabitants of deciduous forests. They live solitary in their natural habitat. Their captive behaviour was studied by taking two Asiatic black bear pairs as study subjects in Lahore Zoo, Pakistan. The study was based on the provision of environmental enrichments to the bear pairs. Each pair's pre-enrichment activity budget data was collected by scan sampling method of 70 h, documenting the cage area and behavioural ethogram. The observed behaviours were resting, eating, drinking, locomotion, aggression, urination, defecation, fighting, pacing, playing, foaming, cage exploration, and being out of view. Two different enrichments were installed for two pairs. The first pair was provided with a feeding enrichment consisting of a large wood log applied with small wooden branches on it, upon which food-filled plastic tires were hung. The second enrichment was installed in the second bear pair's cage, consisting of two wooden platforms attached to the ground with iron rods. A 20-h post-enrichment activity budget of both bear pairs was recorded and compared with their pre-enrichment activity budget. The results showed that there was a significant increase ($p=0.003$) in cage exploration by the installation of feeding enrichment while a significant increase was observed in cage exploration ($p=0.04$), drinking ($p=0.04$), and resting ($p=0.001$) behaviours by the installation of wooden platforms. All the other activities had no significant impact of both enrichments. This study revealed the significance of environmental enrichments on the activity budget of black bears in captivity and can be proved as footprints for future studies.

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Authors' Contribution

NA along with ZA conceptualized the study. NA, ZZ, AB and NN collected information about animals. NA, ZA and KS designed the enrichments. NA and SN gathered data from the field. NA and SRH compiled data. NA, RA, and SA analyzed the data and drafted the manuscript. ZA reviewed the final manuscript and improved it.

Key words

Asiatic black bear, Captivity, Captive behavior, Ethogram, Environmental enrichment

INTRODUCTION

Captive animals face an environment that has been highly different from their natural habitat. This unnatural environment frequently limits the animals from their natural behaviour. A captive environment not only restricts the animal from its natural behaviours but also decreases the time an animal spends performing its innate behaviours in the wild (Shepherdson *et al.*, 1993). However, the exhibition of species-specific behaviour, by the animal in captivity, shows the good health status of the animal (McPhee and Carlstead, 2010).

When animals are compelled to be restricted to express their normal behaviours, they become stressed and frustrated (Friend, 1989). The lack of hiding places, visitors presence, restricted resources, and limited space promote stressful stimuli in captive animals (Morgan and Tromborg, 2007). These factors lead to alteration in the animal's behavioural patterns and the development of abnormal behaviours (Mason *et al.*, 2007). Zoo managers remain concerned about this factor because they are associated with the naturalistic conditions in captivity as well as also with deprived animals' well-being and prosperity (Mason, 1991a). Behavioural inhibition, vigilant behaviour, limited or reduced reproductive potential, immune response, and accumulative health status of animals are the activities that have been affected by chronic stress in captivity (Sapolsky, 1996).

For the improvement of well-being and to reduce stereotypic behaviours in captive animals, London Zoo management has taken steps to introduce captive enrichments which can be beneficial for making the captive environment more natural and productive (Young, 2003). Chronic stress in captivity can be reduced by

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providing environmental enrichments which are an important management tool (Almeida *et al.*, 2018). The more multifaceted and naturally enriched environment, the greater will be the chance for enclosure exploration and escape from being watched by visitors in captivity. An animal can easily manage captivity-related stress if it is provided with an enriched environment that allows the animal to increase behaviour options (Carlstead *et al.*, 1993a).

Animal conservation is an important goal of a zoo (Anderson *et al.*, 2003) which is directly related to animals health and well-being. Asiatic black bear (*Ursus thibetanus laniger*), which is distributed in Northern Pakistan, is enlisted as vulnerable species globally (Goursi *et al.*, 2021). In this regard, this study was conducted at Lahore Zoo to observe the change in the activity budget of two bear pairs through the installation of two different (feeding and wooden platform) enrichments in their enclosure. Our findings could be used by the zoo managers to improve the well-being of Asiatic black bears in captivity.

MATERIALS AND METHODS

The selected site was Lahore Zoological Garden. Lahore is a city with a semi-arid climate where the hottest month is June (Maximum temperature 45°C) while the coldest is January (Minimum temperature 1°C). Lahore Zoo was recognized in 1872 and has an honor to be recognized among the largest zoos located in Asia (Sikander *et al.*, 2015).

Enclosure

The two bear pairs were provided with a place occupying a total area of 823.23 m². This area was divided into two separate outdoor enclosures and four indoor rooms or holdings (Fig. 1). Three indoor rooms occupied an area of 248.46 m². While one indoor room availed the area of 112.26 m². Out of the two outdoor enclosures, one occupied 320.31 m² and the other occupied 142.18 m² of the total area. In this area (823.32 m²) 7 bears were kept and 4 of them were taken as study subjects.

Each outdoor area included a grassy floor with a stony mountain and a small water pool. The indoor area

consisted of a tiled floor, an air cooler, two iron doors, and one window. The two bear pairs were kept isolated from one another and provided with all the above facilities.

Subjects

All four bears were captive breeds which details are given in Table I. The bears were studied on the basis of following the behavioural ethogram. Resting (sitting or lying with closed or open eyes, not doing anything), eating (tearing or grinding something by the use of teeth), drinking (taking in water or any other liquid), locomotion (changing place by walking in a specific direction with a specific objective), aggression (expression of ferocious behavior, ready to attack), urination (excreting urine or urinating), defecation (releasing fecal matter), fighting (attacking animals with aggression), pacing (repeatedly aimless locomotion in the same path), playing (engaged in stimulated activity, with objects or their partner), foaming (foamy white saliva kept in the mouth or dripping down), cage exploration (bear investigating its surroundings by sniffing or by exploring objects), out of view (animals in an enclosure, being invisible).

Procedure and data collection

A total of 70 h of data were collected before enrichment provision to both bear pairs. Observations were made from 8:00 am to 6:00 pm (8:00 am to 1:00 pm on one day and 1:00 pm to 6:00 pm on another day) by the scan sampling method. Scan sampling is a method in which the animal's behaviour is taken after a short time interval and then the observer moves to take the behavioural observation of the next animal. The scans are conducted mostly at regular intervals or as quickly as possible (Man, 1999). The data were collected in April 2018 (temperature ranged from 24-33°C) and it was taken as pre-enrichment data. Each animal was observed after 5 min intervals and its present behaviour was recorded.

Both bear pairs were given bread, apples, watermelons, melons, apricots, plums, and cucumbers as a daily ration (Supplementary Fig. 1a). Both pairs were given food once a day in the indoor area, facilitating the animals to be invisible during feeding time at noon (Supplementary Fig. 1b).

Table I. Description of study subjects.

Enrichments	Animals	Sex	Age at the time of study (Years)	Birth	Rearing	Reproduction
Enrichment 1	Black bear	Male	3.5	Captive born	Parental	None
	Black bear	Female	3.5	Captive born	Parental	None
Enrichment 2	Black bear	Male	7	Captive born	Parental	Sire of cubs
	Black bear	Female	7	Captive born	Parental	Dam of cubs

The feeding enrichment was applied on 15 June 2018 to the outdoor area of pair 1 which was younger than pair 2. This enrichment was installed in the outdoor area of the enclosure and food timing was kept the same as earlier. The enrichment consisted of a large wood log on which 3 small wood logs were attached as branches by iron nails so that the animal could not apart them. Then three rubber tires were applied to each small wooden branch (Supplementary Fig. 1d). The tires were filled with food items (Supplementary Fig. 1c). In this way, it was made necessary for animals to climb up to the wood log to get the food. The given food consisted of bread, seasonal fruits, and vegetables which was a routine ration of the bears. Then the observations were made from 8:00 am to 6:00 pm (temperature ranged from 30°C to 42°C), after 5 min intervals by scan sampling method, and a total of 20 h post-enrichment data were collected. To make the data more comprehensive, each activity of a bear pair was converted into a percentage and the total activity budget of pair 1 was calculated.

The second enrichment was installed in the outdoor area of bear pair 2 on 10 July 2018 (temperature ranged from 33°C to 36°C) and a total of 20 h data were collected. This enrichment consisted of two wooden platforms supported by iron stands to the ground. One platform was applied as a roof of a swing (5 ft. above the ground) and the other was directly fixed to the ground by iron stands (3 ft. above the ground) (Supplementary Fig. 1f, g). This enrichment was applied in the outdoor area of the cage while the feeding pattern was kept the same for this pair as it used to be in pre-enrichment condition. The total activity budget of pair 2 was recorded by the scan sampling method from 8:00 am to 6:00 pm and a total of 20 h of post-enrichment data were collected. The recorded activities were converted into percentages and results were obtained.

Statistical analysis

The statistical tool, SPSS version 26 was used for statistical analysis, and pre and post-behavioural scans for each activity were compared by applying paired sample t-test (for parametric data) and Wilcoxon rank test (for non-parametric data).

RESULTS

Effect of feeding enrichment

In pre-enrichment conditions, the first bear pair was provided food in the indoor area making them invisible to the audience for a longer period (29%). After feeding enrichment installation, this behaviour was reduced (20%) and the bears had to take food in the outdoor area. This made the bear pair to be more visible to the audience. As

this enrichment contained food-filled tires, on wood logs rising above the ground, it induced the animal to do an effort to get the food. They stood on their hind limbs while raising their forelimbs to reach the food. They needed physical exertion for getting food (Supplementary Fig. 1e).

The increased feeding mechanism complexity enhanced their locomotion and playing activities which were increased from 18% to 23% and 11% to 14% respectively (Supplementary Fig. 1e, 2A). It made the bears more active and able to burn more calories in captivity.

The provision of feeding enrichment also enhanced the cage exploration from 3% to 15%, anyhow, no pacing was recorded in pre and post-enrichment conditions. These increased the activeness of bears and they changed their routine activities in captivity. A statistical analysis of the results is given in Table II.

Table II. Statistical analysis.

Behavioural parameters	Enrichment 1 (Feeding enrichment)			Enrichment 2 (Wooden platforms enrichment)		
	p-value	df	t	p-value	df	t
Resting	0.38	7	0.94	0.001	7	5.08
Eating	0.10			0.06		
Drinking	0.67	7	0.44	0.04	7	2.53
Locomotion	0.73	7	0.36	0.10	7	1.84
Aggression	0.18					
Urination	0.66					
Defecation	0.18			0.18		
Fighting	0.06					
Playing	0.89	7	0.36	0.06		
Foaming	0.31			0.30		
Cage exploration	0.003	7	4.34	0.04	7	2.38
Out of view	0.15			0.30	7	1.10

Effect of wooden platforms

Bear pair 2 was older than pair 1 and hence was lesser agile and active. However, the provision of enrichment in the form of wooden platforms increased their activeness. They showed more resting behavior in pre-enrichment (47%) conditions which was reduced (25%) in post-enrichment condition (Fig. 2B). Anyhow, their feeding activity was not observed to be remarkably altered as they were still fed in indoor area and feeding pattern was kept the same. This enrichment increased the visibility of the bears to visitors as they preferred to be more in the outdoor area.

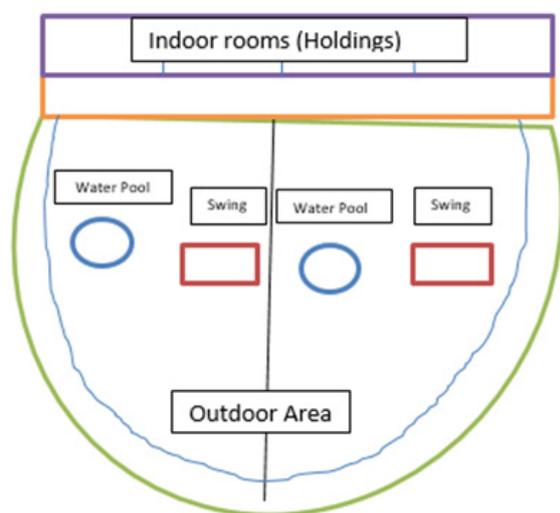


Fig. 1. Black bear enclosure in Lahore Zoo.

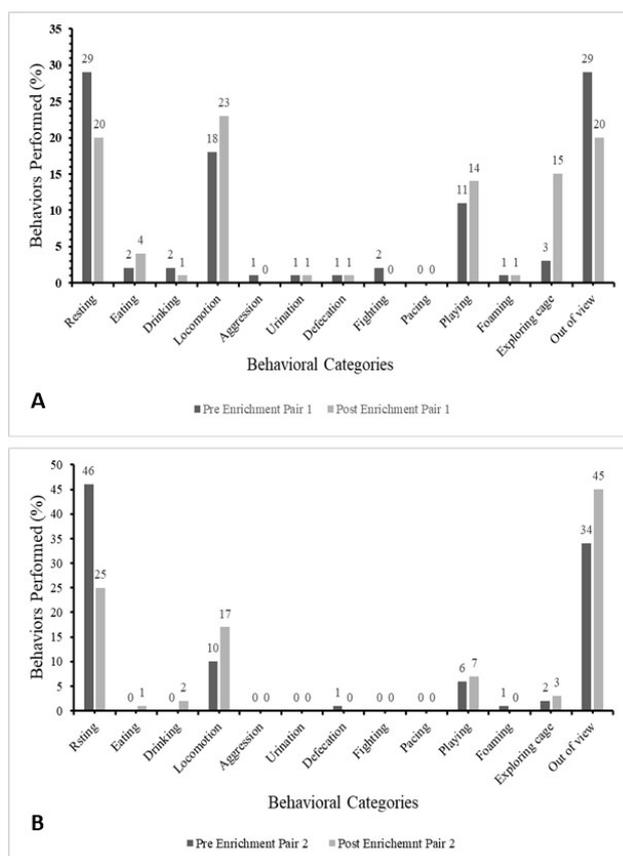


Fig. 2. Pre and post-enrichment activity budget comparison of bear pair 1 with feeding enrichment (A), and bear pair 2 with wooden platforms (B).

Although the second pair was aged and less agile, they showed an increase in locomotion from 10% to 18%. They showed more interest in the surrounding area and an enhanced cage exploratory behaviour. This enrichment increased their activeness and motility. No reading was observed for aggression, urination fighting, and pacing in pre and post-enrichment conditions. A statistical analysis of the results is given in [Table II](#).

DISCUSSION

Animals in wild environment struggle for shelter, gain food and escape from predation. On the other hand, in captivity, they do not struggle for their needs. The unnatural simplicity of the environment makes it frustrating for captive animals to live. The installation of enrichments in cages is a step forward to make the captive environment close to that of the wild ([Carlstead *et al.*, 1991](#)).

The one aspect of a captive animal's life is covered by feeding and the animal spends most of its time on it ([Mills *et al.*, 2013](#)). In this study, feeding enrichment affected the activity budget of bear pair 1 as they exhibited more diversity and agility in their activities. Prior they were provided the food in the indoor enclosure and hence they used to spend most of their noontime indoors and remained invisible to visitors. The enrichment fixation in the outdoor area, made the animals to get their food outdoors and become more visible which had a great impact on visitors' attraction. It also resulted in an increased 'visitors- animal interaction' or inter-species interaction. The purpose of visitor-animal interaction has been to endorse the sense of connectedness and responsiveness in behaviour, for animals' well-being, and its better conservation in zoos as they are not only for visitors' amusement but also for animal welfare and conservatory purpose ([Morgan and Tromborg, 2007](#)). Some involvement of commensalism behaviour appeared as the crows and sparrows came for getting that food, making the enhanced environmental complexity. The food was put in rubber tires and animals needed to find that out, it overall increased the exploratory tendency in bears and increased cognitive behaviour. This enrichment allowed the bears to burn more calories as they were compelled to struggle to get the food. Feeding complexity makes the animal exercise its body which increases physical agility and implies cognitive challenges ([Podlesnik and Gomez, 2016](#)). The feeding enrichment was installed in the summer season so the animals used to take food from the outdoors and ate that indoors (as they were habitual of it) where they were provided with an air cooler, ice blocks, shade, and hiding opportunities. Their eating duration outdoors could be increased if the enrichment would be installed in winter or in a shady place.

The wooden platform enrichment provoked lesser behavioural diversity in pair 2 as compared with pair 1 with feeding enrichment. The first reason was: feeding was the basic need of animals and it can't be overlooked. The second reason was: this bear pair was older and kept in the same cage for seven years. Older bears normally show lesser activities and lesser diversified behaviour (Ames, 1994, 2000). Anyhow, the increased activeness in pair 2 from pre-enrichment to post-enrichment conditions reveals the significant impact of wooden enrichment. As the animal's reactivity and behaviour are the key indicators to evaluate an animal's prosperity level in captivity (Mansour et al., 2010).

Both bear pairs were found to salivate or foam in summer noon timings. Bears foam in stressful conditions and they showed it in only a fraction of time. No pacing was recorded in all pre and post-enrichment behaviours which indicated the appropriate status of bears in the zoo as pacing is a clear sign of stress (Vickery and Mason, 2004). The captive animals can acquire a good health status through a greater variety of food provision ways, more variety in environmental stimuli, and increased muscle activities. In short, motility is compulsory for a captive animal's health (Chamove and Moodie, 1990).

The provision of both enrichments led to a significant increase in behavioural diversity and reduced resting. It proved to be more interesting for zoo visitors and it enhanced animal welfare in captivity.

CONCLUSION

Asiatic black bears are natural inhabitants of Pakistan but they are declared globally vulnerable (Goursi et al., 2021). A zoo aims to conserve a species and maintain its natural behaviours in captivity by providing it with different sorts of enrichments. By keeping the same purpose in view, two Asiatic black bear pairs were selected in Lahore zoological garden. A feeding enrichment was installed in the enclosure of one pair and a wooden enrichment in the enclosure of the second pair. It revealed that there was a significant increase in cage exploration by application of feeding enrichment while there was a significant increase in drinking and cage exploration activities by the provision of wooden enrichment. Both enrichments also reduced the resting behaviour in bears. Lowering the resting behaviour ultimately leads to the behavioural complexity which helps to optimize the health status of captive bears. In conclusion, animals can exhibit diverse behaviours in captivity if they provide with an enriched and multifaceted environment.

RECOMMENDATIONS

It was appreciable that no abnormal behaviour (pacing) was found during this study but it can be suggested that the provision of trees and shade in the outdoor area was mandatory. In this way, the animal will spend more of its time in the outdoor area which will ultimately increase the visitors' attraction. Secondly, bears were given food only once a day and they consumed it all at once. It can be suggested that they may provide the same food in fractions for better digestion. In addition, bears were provided the fruits which were already cut and quite easy to eat. The provision of intact large fruits, like watermelons and melons, can make their feeding time prolonged and it may engage the animal for a longer time. It can make an ease for the animal to cope with boring captive conditions and enhance cognitive behaviours.

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Ethical statement

No animal was harmed or disturbed during this research.

Supplementary material

There is supplementary material associated with this article. Access the material online at: <https://dx.doi.org/10.17582/journal.pjz/20221014091028>

Statement of conflict of interest

The authors have declared no conflict of interest.

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