



Impact of Different Captive Environmental Conditions on Behavior of African Lions and their Welfare at Lahore Zoo and Safari Zoo, Lahore

Bushra Nisar Khan¹, Rida Ahmad^{1,*}, Zulfiqar Ali², Shahid Mehmood¹, Hassan Raza¹, Muhammad Azhar³ and Anam Zakir⁴

¹Centre for Undergraduate Studies, University of the Punjab, Lahore

²Department of Zoology, University of the Punjab, Lahore

³Veterinary Officer, Safari Zoo, Lahore, Pakistan

⁴College of Statistical and Actuarial Sciences, University of the Punjab, Lahore

ABSTRACT

The goal of current research was to evaluate the behavioral adjustments of African lion *Panthera leo* in different sized enclosures. A group of African lions was observed at Lahore Zoo having one solitary lion, one breeding pair and a pair of siblings that was correlated with group of the same composition at Safari zoo Lahore. The frequency of different behavior patterns displayed by these lions was studied at both study sites for three hours once a week by instantaneous sampling method for 16 weeks, from 18th April to 8th July in 2014. The frequency of stereotypic behavior including auto mutilation, refusal of food stuff, feces licking, unnatural aggressiveness, pacing, head tossing was more periodic in lions housed at Lahore Zoo (site 1) in contrast to lions at display at Safari zoo Lahore (site 2). The frequency of natural behavior was periodic in African lions housed at Safari zoo Lahore. In the present study stereotypic behavior in lions represented here as a tool to measure the level of comfort at housing sites. This behavioral display also defines the safety of these groups of lions kept in distinct captive environment. This is evident that the quality of lodging environs and area range had solid connection with frequency of various normal and abnormal types of behavior in captive animals.

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Authors' Contribution

BNK, RA and MA collected data and wrote the article. ZA helped in writing manuscript. SM and HR helped in data collection and compilation of results. AZ helped in compiling results.

Key words

Stereotypic behavior, African lions, Lahore zoo, Safari zoo Lahore, *Panthera leo*.

INTRODUCTION

Historically lions ranged from “Africa, east across southern Asia into India, and north into southeastern Europe”. Thousands of years of human oppression and habitation loss have extremely condensed the scattering of lions (Nowell and Jackson, 1996). After the Siberian Tiger, the lion is the largest, brawny and dominating feline in size in the world. These are huge cats and are exceptional among felines in different ways as they are extremely social. Young lions, cubs spend most of their time playing and enjoying together. It really helps them to improve their hunting skills. They remain in groups, as a family, known as prides (<http://a-z-animals.com/animals/lion/>). In an area teeming with magnanimous prey, lions devote about twenty hours per day sleeping.

In the late afternoon they are fully energetic, mainly mingling with the pride. Hunting mostly takes place at

dawn. Lions contain short coat of yellowish brown fur and long tail having longer fur at the end. Other felines contain apparent bold stripes but the markings present on the coats of lions are much fader that aids them to remain unperceived when following prey in tall grass (<http://a-z-animals.com/animals/lion/>). In the wild, even though lions and tigers are nocturnal they mate and hunt opportunistically during day time (Bashaw *et al.*, 2007). The human population is increasing at a fast pace all over the world, hence increasing the difficulty for carnivore population (Fuller, 1995; Nowell and Jackson, 1996).

The visitors' connection for zoo lions also has uncomfortable side effects, which could disrupt or maybe provoke the lions while under observation (Khan, 2013). The ecological threat to these large carnivores including loss of natural dwelling grounds, diminishing natural prey, captivity and other recreational attributes are most remarkable (Woodroffe, 2000; Bauer *et al.*, 2008).

Captivity involves keeping animals out of their indigenous habitats, transporting them to pronounced distances and retaining them in estranged environment. Their independence is extremely restrained there. It is a

* Corresponding author: ridaahmad411@gmail.com

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known fact that keeping the animals away from the wild and restraining them in zoos and other captive sites can cause deprivation of prodigious goods. The behavior of wild animals can be defined as the aggregate of responses or reactions or movements made by an organism in different situations (Lindburg, 1988). African lion also displays different behavioral patterns in different situations as done by other wild animals.

As the captive animals are in an environment different from their natural environs, social association may develop into idiosyncratic activities. The energy of animals in captivity is transformed from normal behavior to anxiety and unimaginative behavior that is not apparent in the wild (Animal Protection Institute, 2000). Khan (2013) stated that visitors' contacts with captive animals also have contrary effects that can disturb or upset the animals.

Eisenberg (1981) stated that the normal behavior could be defined as demonstration of phenotypic traits in a way for which nature had designed it. In captivity these behaviors are replaced by anomalous ones or may be stereotypic like pacing *etc.* (Carlstead *et al.*, 1996).

In addition to confined movement, forced adjacency and lessened retreat space, restricted feeding room, conservancies in abnormal gregarious groups and other limitations can cause stereotypic behavior in animals (Morgan and Tromborg, 2007).

The humans conserve wild animals in zoological gardens for the purpose of preservation, education, exploration, fun and relaxation (Pitsko, 2003). Altering association amongst humans and animals has affected the improvement of contemporary zoological gardens. Isolated assemblages of exotic animals were formerly a status symbol of the rich, such as the "Versailles menagerie, established by Louis XIV" whereby he managed to erect an inclusion for lions and elephants nearby his citadel (Anderson, 1995). Huge mammals are frequently housed in inclusions that do not offer chances for the rally of normal behavior (Mellen *et al.*, 1981; Forthman *et al.*, 1992). Some inclusions may not even offer satisfactory opportunity to execute basic behavior (Hutchins *et al.*, 1983).

As an endeavor to please visitors and to improve animal welfare most of the modern zoos are using realistic exhibits (Finlay *et al.*, 1988). The knowledge how does large carnivore inhabitants, adjust themselves in artificial landscapes helps organizers to maintain and display them in a judicious manner. In the wild carnivores have natural and wide home ranges in contrast to zoological gardens. Whereas, in artificial environment they may develop some anomalous behavior if those environs do not permit them to perform natural behavior. In a captive environ

an animal may not get any provocation, need or chance to exhibit the behaviors that are essential to flourish in natural surroundings (Bashaw *et al.*, 2007). Animals kept in unnatural habitats are opposed by a broad range of possibly provoking environmental challenges. These stereotypes are repetitious behaviors that have no evident function and maybe it is due to some ecological problem that a captive animal is not able to solve (Price, 2010). Good physical and mental behavior is the basis of animal well-being. Biological functions of an animal can be improved by modifying enrichment and ameliorating their captive environs (Price, 2010).

The study was aimed at comparing the behavioral patterns of African lion/s kept in Lahore Zoo and Safari zoo Lahore. It was designed to examine different behavioral patterns of captive lions whether normal or abnormal, impacted by different enclosure sizes and environmental conditions.

Table I.- Comparison of enclosure variables at both captive sites.

Study Site	Arena	Substrate	Plantation	Pool	Shade
Lahore Zoo	Small 24,500 ft ² / 2276 m ²	Artificial	Absent	Small	Improper
Safari zoo Lahore	Large 653,400 ft ² / 60,703 m ²	Natural	Present	Large	Proper

MATERIALS AND METHODS

Animals under observation

The study was carried out on two groups of lions held at Lahore Zoo and Safari zoo Lahore. Each group consisted of five lions including a single lion, one breeding pair and brother sister duo at Lahore zoo (site 1) and five lions of the similar combination at Safari zoo Lahore. Study animals at Lahore Zoo included Tony a single male lion of 19 years, one breeding pair (Rangeela, 16 years old male and Sarmeeli, 18 years old female) and a duo of siblings (Chand and Tara) of 2.5 years. At Safari zoo Lahore (site 2), 17 years old single lion male (Shero), one breeding pair (Jumbo, 19 years old male and Marry, 18 years old female) and two siblings, 3 years old. The names Ricky and Ticky were under consideration.

At site 1, single male lion Tony was kept alone in his cage, he was separated from Rani three days before the study as she was transferred to Bahawalpur zoo. Shero, the single lion at Safari zoo Lahore got comparatively fewer chances than others to visit in the open.

Table II.- The ethogram of different abnormal and normal behavior observed at both captive conditions.

Explanation of the behaviors	
Abnormalities	
Food snub	Denial by individual to ingest adequate nutritious feed
Pacing	Walk with a steady speed, especially without a particular destination
Abnormal aggressiveness	Unusual anger and roar
Auto mutilation	Self-injury, self-harm
Feces licking	Licking the self-refusal
Grooming	Prepare or train for particular activity or purpose
Head tossing	Shaking head aberrantly
Natural behaviors	
Playing	Playful, sportive behavior displayed by animals when they are joyful
Climbing	An event that involves rising to higher point
Roll over/stretch	The act of physically reaching or thrusting out
Scent marking	A characteristic stench that the animals lodge on the surface of ground. Like urinating which serves as distinguishing indicator to other members of the group
Use of water pool	Use of water pond for cooling itself to ward off heat, bathing, enjoying and playing
Digging	Digging of channels for safety by animals when they feel challenged.
Stalking	Pursue or approach stealthily, stride somewhere in a proud, stiff or angry manner.
Sleeping	The suspension of consciousness and decrease in metabolic rate, the natural state of rest during which you become unconscious
Laying on back	The relaxation position of animal
Grooming	Brushing and cleaning the coat of animals, self-grooming to remove dirt from the body or fur.
Mating	The action of animals coming together to breed; copulation.

Study sites

The Lion House at site 1 covers an area of 24,500 ft². This is an old Victorian style building with dry moats, small water pool and scanty vegetation in the outer open area of 600 ft². The covered area, 18,500 ft², comprises of four rooms, two night rooms in the back and two for animal display in front with the protective grill. Lions visit the outside paddock on alternate days.

Lion Safari at site 2 included 653,400 ft² open area and 68450 ft² covered area. A large water pool, indigenous trees, artificially constructed dens and large grassy grounds are provided in the open area. The covered area comprises of four rooms, two night rooms in the back side and two for animal display in the front with protective grill.

The rooms at both the sites are exact replica of each other. All study lions at site two most of the time remain in the open area and only occasionally are allowed in the rooms during the day.

Sampling method

The instantaneous sampling method (Altmann, 1974) was employed to record the behavior of lions for 16 weeks,

from 18th April to 8th July in 2014 for total 48 h (3 h once a week) at both study sites by different observers.

Different types of behavior patterns observed are given in Table II.

Frequency was calculated as number of times behavior displayed/total time of observation (Lucy and Newton-Fisher, 2004).

Chi Square Test of Association for Attributes was used to check the association and correlation between variables of two categories, animal type and their behavior (Walpole, 1968).

For formulation of hypothesis, there is no association between type of animal and their behavior (Ho), an association exists between type of animal and their behavior (Ha), level of significance was $\alpha = 0.05$ and test statistic used:

$$X^2 = \sum_{i=1}^n \frac{(o_i - e_i)^2}{e_i}$$

Where, X^2 is Chi square, o_i is observed frequency, e_i is expected frequency and n is the total number of observations.

Critical region: If value of $p < \alpha$ then reject H_0 otherwise accept H_0 .

Mann whitney U test (independent sample test) is used when data are non-normal and we are comparing two independent sample means. The test has been used because behavior in Lahore zoo and Safari zoo Lahore are totally independent of each other. As both sites do not have any influence on each other.

$$U = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - \sum_{i=n_1+1}^{n_2} R_i$$

Where, U is Mann-Whitney U test, n_1 is sample one size n_2 is sample two size and R_i is sample size rank

For hypothesis formulation, there is no difference in behavior at lions of both study sites (H_0) and behavior of lions at both study sites is different (H_1).

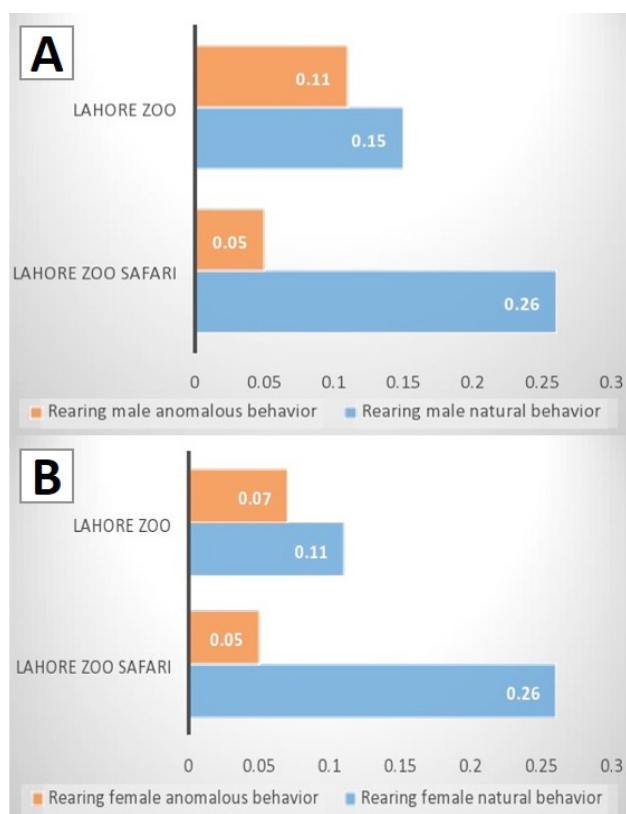


Fig. 1. Frequency of different behaviors of rearing male (A) and female (B).

RESULTS

The results showed that abnormal behavioral patterns including auto mutilation, refusal to food stuff,

feces licking, unnatural aggressiveness, pacing and head tossing (Table II) were seen in the lion groups at both captive sites however these conducts were more periodic in lions housed at Lahore Zoo while the display of normal behavior was more periodic in lions at Safari zoo Lahore (Fig. 1). Solitary lion at Lahore zoo showed 0.13% abnormal behavior and 0.19% normal behavior but the one at Safari zoo Lahore exhibited 0.09% abnormal and 0.26% normal behavior. On the other hand, siblings showed 0.05% anomalous and 0.19% natural conducts at Lahore Zoo, but with considerable difference, study lions exhibited 0.03% abnormal and 0.21% natural behavior at Safari zoo Lahore. In breeding male there was considerable difference of natural behavior at both sites as the breeding lion showed 0.15% of normal behavior at Lahore zoo whereas the breeding male at Site 2 displayed 0.26% of normal behavior. But in case of stereotypic conduct in comparison with 0.11% of abnormal behavior was shown by lion at Lahore Zoo, only 0.05% of abnormal conduct was shown by lion at Safari zoo Lahore. Breeding lioness at Lahore zoo showed 0.07% of abnormal behavior and only 0.11% of normal behavior as compared to the breeding female that showed 0.05% stereotypic conduct and 0.26% of normal behavior.

Table III.- Chi-Square test statistics and P-value of Safari zoo Lahore and Lahore Zoo.

Site	Chi-Square test statistics	P-value
Safari zoo Lahore	0.02571	0.999918
Lahore Zoo	0.324467	0.98818

Chi-Square test of association

We performed chi square test of association for both sites *i.e.* Lahore Zoo and Safari zoo Lahore (Table III). We inferred that there was no association between type of animal (Solitary lion, breeding male, breeding female, sibling male, sibling female) and their behavior (normal and abnormal) for both sites.

P-value was compared at 5% level of significance. For both sites $p > \alpha$, hence H_0 cannot be rejected.

Mann Whitney U test was used to compare the means of sample which showed that behavior was significantly different for zoo and safari with p-value 0.000. Hence H_0 is rejected and H_1 is accepted *i.e.*, there is a significant difference between the behavior of two sample means. Figure 2 shows comparison of normal and anomalous behavior of lions at Lahore zoo and Safari zoo Lahore. Bars with asterisks show significant difference in behavior for respective groups.

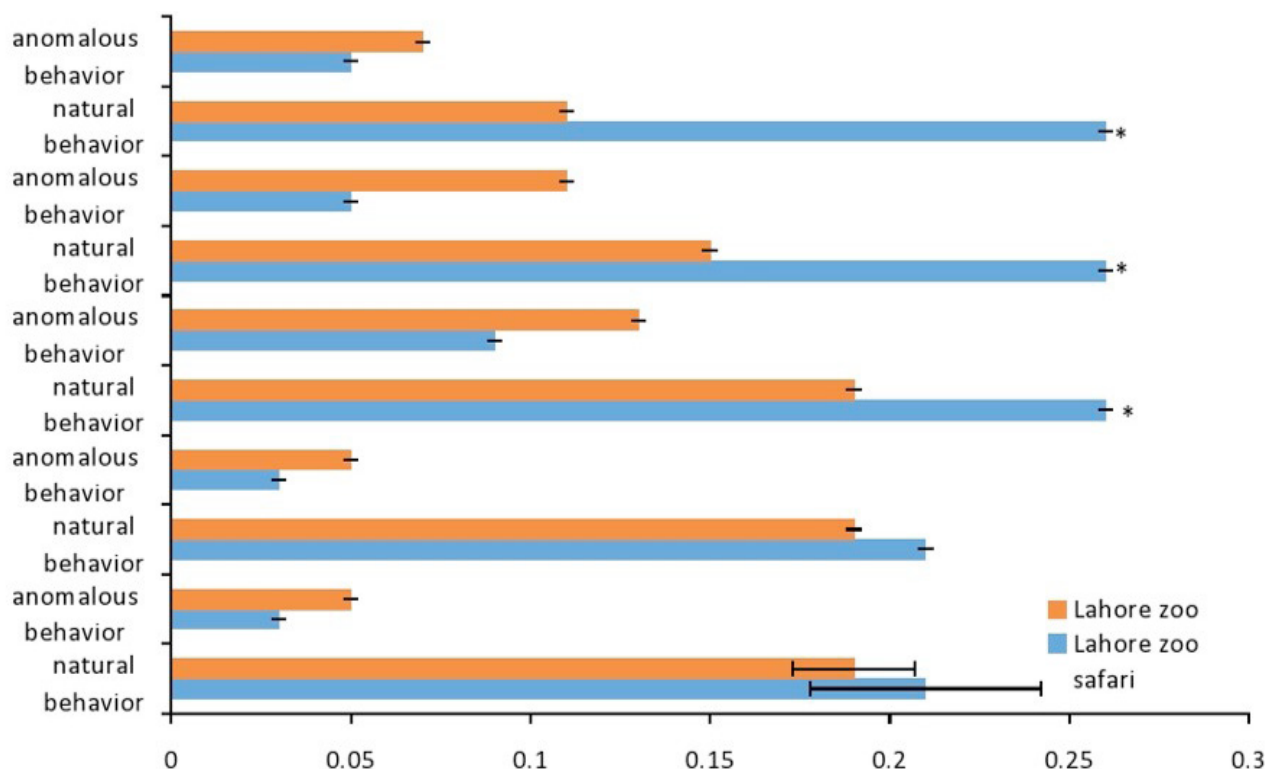


Fig. 2. Behavior of lions at Lahore zoo and Safari zoo Lahore.

DISCUSSION

The data provided strong evidence that study animals showed abnormal behavior in captivity. It also suggested that the frequency of normal behavior in captive lions restricted to a small facility was less than the frequency of abnormal behavior shown in comparatively large facility. However, there were differences in frequency of abnormal behavior displayed by different individuals in different conditions at both captive sites. Study lions kept at Lahore Zoo showed more anomalous behavior than the lions on display at Safari zoo Lahore. Since the group of African lions confined at Lahore zoo had small housing facilities (24,500 ft²) with tiled floor and a small pool, inadequate enrichment and scantier vegetation cover whereas the facility at Safari zoo Lahore covered an area of 653,400ft² (1:8 ratio) having proper housing facilities like muddy substrate, naturally enriched habitat and larger water pool than that at Lahore Zoo.

The highest percentage of abnormal behavior was shown by solitary lion in the whole group at both study sites (Fig. 3). Siblings showed the lowest percentage of abnormal behavior including pacing, feces licking, auto mutilation, head tossing, abnormal aggressiveness and refusal to food, among all at both study sites (Fig. 4A,

B). Yu *et al.* (2009) also identified limited behavioral diversity, anomalous behavior and extreme inactivity as mutual problems in captive animals.

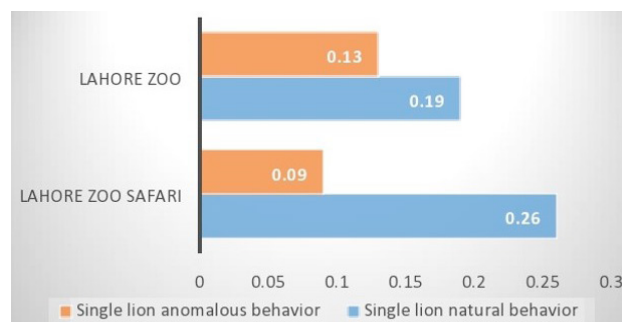


Fig. 3. Frequency of different behaviors of solitary lions.

Normally lions are social animals and remain in prides. The reason behind solitary lion showing the highest abnormal behavior could be the lack of socialization, as they didn't have a pride or any family member to live with. In case of solitary lion (Tony) at Lahore zoo it was feeling lonely as it was separated from the female (Rani) only three days before the study was started.

Lions in captivity faced many challenges, reduced

enclosure area being the foremost. Lions in captivity get about 18,000 times less area than in the wild. Young lion cubs spend most of their time playing together that help them to learn hunting techniques (<http://a-z-animals.com/animals/lion/>). Whereas, adults devote their time to protect their pride and hunting; in captivity they pass their time by sleeping and pacing (Bashaw *et al.*, 2007). Overall vegetation cover at Lahore zoo is scanty whereas the open area and vegetation cover at Safari zoo Lahore is considerably more than that at Lahore Zoo. The covered area (built in area) at both captive sites is of a similar design however size of the total area of the facility is the major difference (site 1: 24,500 ft² and site 2: 653,400 ft²). The built-in area at Lahore Zoo was 3.7% less than that at Safari zoo Lahore. Each study lion at Lahore zoo had 4900ft² area while at Lahore Zoo Safari each individual lion got 130,680ft² area. A bigger inclusion not only provides proper space for workout, it also permits zoo authorities and animal keepers to provide a wider variation in enrichment like vegetation, ledges, and different substrates (Law *et al.*, 1997; Mellen and Sheperdson, 1997). At Safari zoo Lahore, shelters, natural substrates, woodland, bare rocks, marking spots, pond facility, vegetation and larger space to hide and seek logs were taken as important factors for the better health of captive lions.

Larger area and greater enrichment resulted in enhanced activity level of lions at Safari zoo Lahore whereas in a smaller area and negligible enrichment at Lahore zoo, activity level of study lions was greatly reduced. It was difficult to provide animals with the variety of enrichment in reduced inclusions as there was less useable space due to limited area. Study lions rested most of the time and got up only for eating. Food retrieval is not a difficult task for them as zoo keepers serve them the recommended 5-8 kg beef in their cages. Food retrieval should be made difficult to increase their activity level. Similarly, enrichment level should also be increased. The food should have been wrapped in some paper or provided in a frozen state as it is prone to flies which are dangerous both for animals and visitors.

Lyons *et al.* (1997) reported that larger enclosures generally had greater levels of enrichment. This agrees with our observations that larger open area in Safari zoo Lahore than that at Lahore zoo provided more enrichment to the animals than at Lahore zoo where enrichment was almost absent. Environmental enrichment can help captive animals both physically and mentally (Young, 2003). Enrichment even in a small area can make a big difference, therefore some enrichment plan must be introduced to make the habitat joyful and stress free.

Study lions showed affection within their group and exhibited normal behavior like touching, licking, rubbing at Safari zoo Lahore but this kind of behavior was much less in lions at Lahore Zoo. One of the most essential factors persuading the foundation and maintenance of effective social groups in captivity is the group size. The breeding pair was also affected by group size, enrichment and specially the extent of the area. Lack of privacy also impacted the normal behavior *viz.*, eating, drinking, sleeping *etc.* that were to be performed in the presence of visitors especially at site 1 (Fig. 1A, B). For zoos, proper social grouping is of supreme importance to help exhibit species-typical conducts, and achieve captive breeding objectives as well. The importance of group size was taken into account by Safari zoo Lahore and the whole group was kept free in the open area of Safari most of the time so that they could socialize with each other. The breeding pair was also affected by group size, enrichment and specially the extent of the area. In animal husbandry enrichment is a principle that increases the quality of life of captive animal by providing essential stimuli for proper physiological as well as psychological welfare (Shepherdson, 1998).

Siblings, enjoy many acts together in the pride, like hunting and playing, but due to reduced area and different environmental conditions, pacing and aggression was the dominant behavior in study lions at both sites.

Evaluating the wild-type behavior of captive lions

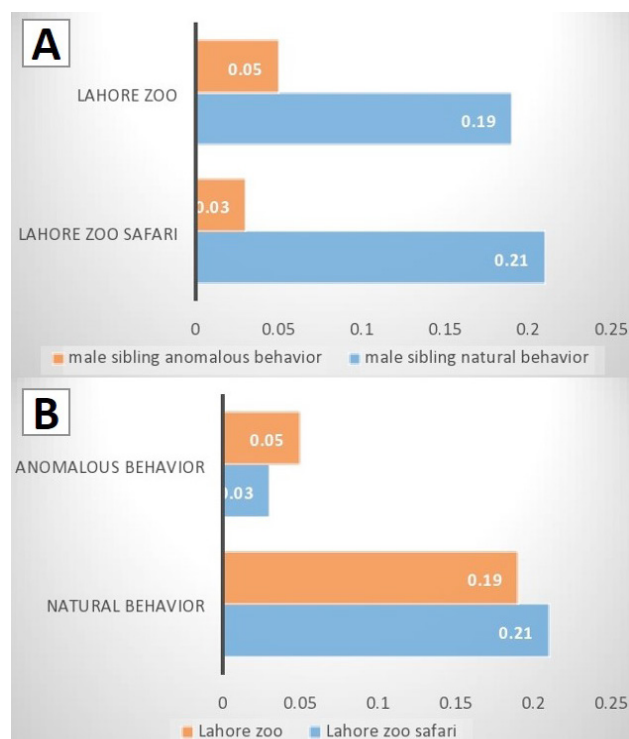


Fig. 4. Frequency of different behaviors of male sibling (A) and female sibling (B).

vis. a vis. behavior in the wild, without influencing it, is rather difficult (Isabell and Young, 1993). Markowitz and LaForse (1987) reported that captive individuals showed less activity as compared to wild animals. Animals at Safari zoo Lahore showed more activity than those at Lahore Zoo due to larger and better enrichment facilities at the Safari.

Veasey (1993) concluded that biotic and abiotic factors, whether short or long term, had an adverse effect on animal's behavior that was true in our case as well as lions at display at Safari zoo Lahore were suffering from less behavioral disturbance as compared to lions at Lahore zoo due to better environmental conditions within spacious cages. The environment had also affected the qualitative changes in deportment of captive species (Davies, 1992). The foremost problem with captivity is that all the vital needs for subsistence are taken care of at both captive sites. As the captive lions did not face any danger from the predators, they did not need to hunt or compete with other males for a female. In the absence of any danger from predators, they did not have to remain vigilant visualizing escape from predators while in captivity.

Such omitted behaviors might not be a requirement as such; this may create an emptiness that becomes a problem itself. Because of this emptiness the lions showed abnormal behavior. This emptiness was more evident at Lahore Zoo. As they could not have overcome this emptiness by adopting natural behaviors, they resorted to stereotypic or unnatural behavior (<http://a-z-animals.com/animals/lion/>).

Captive animals are bereft of their native environment, societal interaction and characteristic activity, hence the animals in confinement often distract their energies and anxiousness into stereotypical behavior that are not apparent in animals in the wild (Animal Protection Institute, 2000). Lions in the wild usually devote 10 h of the day to hunting and safeguarding their pride and territory. But in captivity they were served daily meals without any effort and being in captivity there was no need to safeguard their groups at study sites. As lions in captivity deprived of the opportunity to do these tasks, release their energy by replacing their natural activities with pacing and other stereotypic behavior in their cages which was more evident at Lahore Zoo than at Safari zoo Lahore. Solitary lion, male and female breeding lions, male and female siblings showed abnormal behavior of 0.09%, 0.05%, 0.05%, 0.03% and 0.03%, respectively at Safari zoo Lahore against abnormal behavior shown by lions at Lahore Zoo: 0.12%, 0.10%, 0.06%, 0.04% and 0.04%, respectively. It is common for lions to continually pace up and down their inclusion forcing the zoo management to put concrete pathways along the boundary to halt the ground wearing down (www.captiveanimals.org). Type of floor also affect thermoregulation and many behavioral

changes due to temperature responses can be improved by altering the substrate (Morgan and Tromborg, 2007). Chenault (2002) reported that only by providing lions with chances for workout pacing can be reduced. Solid items have generally been considered more hygienic than wood, straw, chips and mud. Two different types of substrates "natural" and "unnatural" were observed at both the study sites. Natural substrate included vegetation, mud, wood chips or combination of that while unnatural substrate comprised of concrete floors. Enclosure at Lahore zoo has unnatural substrate and animals have to spend almost the whole day in small tiled cages facing great disturbance from visitors as no hiding place is available to rest, to mate and to avoid visitors' vandalism that enhances their abnormal behavior.

Markowitz (1975) argued that just as humans use exercise machines to resolve the consequences of inadequate exercise, captive animals should not be deprived of the chance to energize themselves in a parallel fashion. It seems that animals need to put in efforts to get food; it leads us to suppose that animals perform these functions to remain functional and to employ control over their surroundings (Markowitz, 1982). The study lions loved to roam in the open area at both study sites. If they get an opportunity to spend their time in searching their food or food treats hidden by keepers, it would be a blessing for them. The management of Lahore zoo and Safari zoo Lahore were not following any proper collection plan that could favor the animal welfare; besides this more emphasis was given to visitors than animal conservation and management.

CONCLUSIONS

The study highlights the catastrophic consequences of subduing or reducing the usual development and growth of animals by retaining them in captivity. Bereft of their native environment and communal groupings, these individuals have lost the capability of learning that could support them to achieve their complete potential and understand their genuine being. Instead, their normal activity is transmuted into stereotypical behavior like pacing in their cages. Ice blocks are provided in summer season for temperature maintenance, it can also be used to make frozen treats for animal food enrichment. At both study sites the beef is directly thrown on the floor and animals get their food without any effort. To avoid the animal boredom, the food can be hung or hidden on wooden logs or trees to increase the activity level of lions.

Statement of conflict of interest

Authors have declared no conflict of interest.

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