Research Article *Gajah 41 (2014) 3-11*

The Effect of Visitor Group Size on Stereotypic Behaviour and Use of Available Space by Captive Asian Elephants

Kavitha Krishnan* and Stan Braude

Washington University in St. Louis, St. Louis, USA
**Corresponding author's e-mail: kkrishnan@wustl.edu*

Abstract. We examined use of enclosure space and the effect of human crowd size on stereotypic behaviour by Asian elephants (*Elephas maximus*) at the St. Louis Zoo. We found the adult male and four adult females to exhibit stereotypy. One adult female and none of three juveniles showed stereotypic behaviour. Stereotypy was less when larger crowds of visitors were present. No relationship was found between level of stereotypy and enclosure size or ambient temperature. Elephants used a small enclosure more evenly than a large enclosure. We conclude that large audiences could serve as a source of behavioural enrichment and that space alone is not a key factor in the wellbeing of captive elephants.

Introduction

There are currently 308 elephants, of which 145 are Asian, in 73 AZA (Association of Zoos and Aquariums) accredited institutions in the United States. These institutions are held to strict standards of management and care by AZA guidelines designed to ensure health and behavioural well-being of captive elephants. Captive settings result in a complex relationship between elephants and humans. Elephants experience direct contact with keepers as well as indirect, passive interaction with visitors.

Many AZA affiliated zoos attempt to keep matrilineal families together, but group sizes are limited by space. Zoo management plans take into account the elephant's diet, behaviour, social organization, and biology but can never replace the wild environment (Hutchins 2006). For example our efforts to ensure nutrition can deprive these animals of the behavioural stimulation of foraging.

Interaction with humans has been a major area of study because of the elephants' effects on conservation and fragmentation in the wild (Kumar & Singh 2010). Human activity has been shown to decrease foraging efficiency and induce physiological stress on wild Asian elephants. For example, on the Valparai Plateau, elephants responded to human density by avoiding places where humans were likely to go and by showing increased agitation and alertness. These elephants also had reduced foraging efficiency around humans (Kumar & Singh 2010). Captive-bred Asian elephants are also subject to a wide range of interactions with humans. However, because they fear humans less, they can be more dangerous. In fact, captive-bred elephants assault handlers much more frequently than wild-caught elephants (Hildebrandt *et al*. 2006).

Although elephants in zoos have close contact with keepers, much more of their time is spent in less intensive interaction with visitors. Interactions of other zoo species with visitors have been investigated. Wells (2005) found that low visitor density appears to be less stressful for gorillas. With high visitor density, gorillas showed stereotypic behaviours and behaviours otherwise seen during intra-group aggression (Wells 2005). On the other hand, gorillas at Disney's Animal Kingdom Theme Park did not show significant differences in stereotypic behaviour with small and large crowd sizes but gorillas were less visible when there were large crowds (Kuhar 2008). Although various studies have shown that primates show more aggressive behavior with larger crowd sizes, moderate sized

crowds may provide sensory enrichment in some animals (Fernandez *et al*. 2009). Nimon and Daziel (1992) found that a long-billed corella exhibited more activity and non-stereotypic dancing when there were increased numbers of visitors. However, there seemed to be a limit to how many visitors the corella preferred (Nimon & Daziel 1992).

Both elephants and primates are popular with the zoo visiting public and are often exposed to high numbers of visitors. The number of visitors present at an exhibit can influence sound levels, which can differ drastically from natural environments. (Clubb & Mason 2008). Hosey (2000) showed that there were clear behavioural differences in a number of species when an audience was present or absent. Early studies have shown that human visitors create a stressful environment for captive primates. However, later studies suggest that environments can be created that allow primates to interact with visitors without increasing stress (Hosey 2000).

Stereotypic behaviours are frequently associated with physical confinement, aversive environment, and/or low stimulation (Mason *et al*. 2007). On a physiological level, stereotypies have been associated with a decrease in heart rate and reduced sympathetic nervous system activation due to chronic stress (Koolhaas *et al*. 1999). Stereotypic behaviours have been used as a validated metric of behavioural welfare in captive elephants (Mason & Veasey 2010). For elephants, some common stereotypic behaviours include weaving, head bobbing, trunk tossing, and pacing. These behaviours are more common in older elephants (Gruber *et al*. 2000). An increase in stereotypic behaviour has also been correlated with a decrease in temperature and with proximity to feeding time (Rees 2004).

Physical setting and sensory deprivation may also contribute to stereotypy in elephants. Elzanowski and Sergiel (2006) studied an elephant at the Wroclaw Municipal Zoo in Poland in an indoor pen and an outdoor pen and found stereotypic behaviours were more common when the elephant was placed in an indoor pen after spending time in the outdoor pen. Patterns like these provide valuable clues that have been used to improve zoo management practice and enclosure design.

Zoos continue to adopt new methods of management, care, and enrichment to reduce the frequency of stereotypic behaviour. Many animals, elephants included, engage in stereotypic behaviour that cannot be pinpointed to a particular cause. When causal influences are not clear, providing effective enrichment is difficult. In addition, reduction in stereotypic behaviour from enrichment may take time to manifest itself (Mason *et al*. 2007). This study examined stereotypic behaviour in zoo elephants in order to determine if large groups of human visitors are stressors. In addition, we looked at the elephants' locational patterns within enclosures as an additional indicator of elephant response to human crowds.

Methods

The subjects of this study included nine Asian elephants housed at the River's Edge exhibit at the St. Louis Zoo. They consisted of one adult bull, Raja, and five adult cows: Sri, Ellie, Rani, Pearl, and Donna. All adult elephants were captive born. There were also three female calves: Maliha born to Ellie in 2006, Jade born to Rani in 2007, and Kenzi born to Rani in the summer of 2011. All calves were born at the St. Louis Zoo.

During the entire observation period Raja was separated from the female elephants to avoid potential conflicts that can occur when males and females interact. The cows and calves were placed together, usually in groups of three to four, but Raja was always alone.

The St. Louis Zoo has two adjacent elephant enclosures of 1442 and 693 m^2, separated by a wall (Fig. 1). The enclosures contained trees, tree stumps, ponds, and rock formations (Fig. 2). Raja was always kept alone in an enclosure and was on exhibit more than the others. The other elephants were kept in different groups throughout the observation period. The calves were mainly placed in the exhibit with their mother and one or two other females. The same groups of elephants

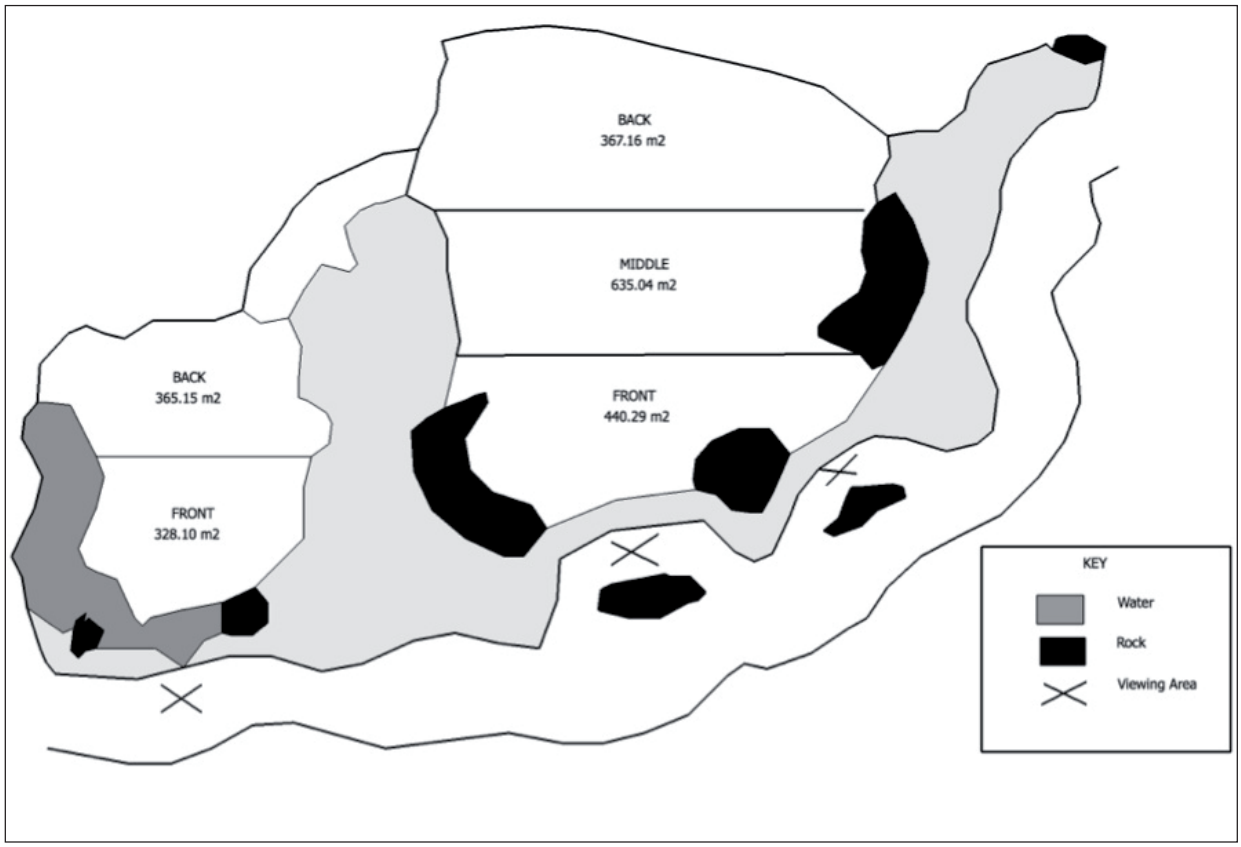

Figure 1. The River's Edge elephant exhibit in the St. Louis Zoo.

were placed together frequently, for example, Rani, Ellie, and Maliha were usually placed together. Many times, the mother was present with the younger elephants. Rani was pregnant during the 2011 observation period and Kenzi was only observed in the fall of 2012.

Usually the small enclosure housed a group of two to three female elephants or Raja and the larger four to six females or Raja (Fig. 2). For quantification of space use we noted whether elephants were located at the front, middle, or rear of the large enclosure and the front or rear of the small enclosure (Fig. 1).

The elephants at the St. Louis Zoo were fed locally grown, grass-based hay. The elephants were also fed pellets, which provide them with additional vitamins and minerals. As treats, the elephants received produce such as carrots, apples, and bananas. In addition to the food provided for them, the elephants also ate from the trees and shrubs growing in their enclosures. The zookeepers normally fed the elephants three times a day by throwing bundles of hay and other items into the holding area.

For this study, the elephants were observed from February 2011 to April 2011 and August 2012

Figure 2. View of the small (left) and large (right) enclosures from the visitor area.

Table 1. Behavioural ethogram.

Sampling	Behaviour	Description
Scan	Drinking	The elephant uses his trunk to draw up water. The elephant then moves the trunk toward his or her head and releases the water into his/her mouth.
	Eating	The elephant uses his trunk to pick up food and uses the trunk to place the food in his mouth.
	Resting	The elephant is standing up but is not making any specific movements in a particular direction. He may also be engaging in body swaying or trunk swaying..
	Grooming	The elephant throws mud or dirt on his or her back using the trunk. The elephant can also use the trunk to draw up water and spray it on the body.
	Movement	Any movement by the elephant in no particular direction in relation to the audience. The elephant can also be moving toward another elephant or engaging in pacing behaviour.
	Play	The elephant picks up food with trunk but does not eat. The elephant uses feet to move ground (mud, dirt, etc); Any social contact with another elephant in a physical manner is included in this category as well.
	Other	Any behaviours that did not fit into a particular category listed above. This included an elephant out of view and elephants swimming.
Focal	Pacing	The elephant makes movement that shows no apparent purpose. There is a repetitive pattern to the walking, and there is no inherent destination.
	Trunk swaying	The elephant moves trunk from side to side without any purpose in the particular act.
	Body swaying	The elephant shifts its weight from side to side in a repetitive motion. The elephant can pick up his feet without making any movement.
	Head swaying	The elephant nods head back and forth without serving any purpose. There is a noticeable pattern in the swaying behaviour.

to December 2012. In December, January, and February, temperatures ranged from 30°F to 40°F; during the spring and fall months, temperatures ranged from 60°F to 70°F. The elephants were never observed in snow or heavy rain. Although zoo visitation is typically higher in warm weather, large and small crowds were observed during all seasons. Observations took place during normal zoo hours, between 9 am and 5 pm.

Focal animal observations and scan sampling were conducted by K.K. in 2-3 hour blocks for a total of 80 hours (the behavioural ethogram is shown in Table 1). Stereotypic behaviour was recorded using focal sampling (Table 1). The type and length of stereotypy was recorded. Scan sampling was conducted to obtain an activity budget of the elephants and assess space use for each enclosure. Scan samples were collected at five-minute intervals. Scans included the activity of each elephant in the enclosure (Table 1) and whether each elephant was in the front, middle or rear of the large enclosure or in the front or rear of the small enclosure (Fig. 1). Not all elephants were present for each observation block, so some elephants have more observation hours than others.

Crowd size was categorized as "high" (greater than 5 individuals) and "low" (5 or fewer individuals) audience attendance. This is consistent with the methods in Anderson *et al.* (2002) who studied the effects of human visitor density in zoo animal petting.

To determine statistical significance ($p<0.05$) between variables under high and low audience attendance, paired difference tests were conducted. To take into account temperature effects that could influence stereotypic behaviour, a line of best fit was determined through linear regression. A Pearson's correlation coefficient was calculated to determine the strength of the linear relationship.

Table 2. Stereotypic behaviour displayed by elephants.

			Minutes observed		% Stereotypy	
Name	Sex	Age	Total	Stereotypy	Crowd size <5	Crowd size >5
Raja	M	19	1325	386	32.17%	25.83%
Sri	F	33	125	21	16.80%	0%
Ellie	F	40	915	250	35.00%	18.85%
Rani	F	15	630	114	15.33%	18.96%
Pearl	F	40	570	4	1.82%	0%
Donna	F	40	505	0		
Maliha	F	5	750	0		
Jade	F	5	825	0		
Kenzi	F	1	210	0		

Results

Of the nine elephants studied five were observed exhibiting stereotypic behaviour) with Raja showing the highest time in stereotypy (Table 2). Extent of stereotypy (Table 2) and type of stereotypy exhibited varied by individual. Raja was the only elephant who engaged in stereotypic pacing. He paced back and forth at the back of the smaller enclosure and diagonally between the back and middle of the large enclosure. Ellie, Rani, Sri, and Pearl all exhibited stereotypic body swaying. Ellie also exhibited stereotypic trunk swaying.

There was little change in stereotypic behaviour over time. Only Ellie displayed significantly different levels of stereotypic behaviour between the two years with an increase from 13.60% in 2011 to 26.13% in 2012 (paired difference test, $p=4.0 \times 10^{-6}$).

Elephants spent varying amounts of time in the small and large enclosures but the percentages of time engaged in stereotypy were not significantly different between enclosures for any elephant (Fig. 3). Elephants were observed across a wide range of weather conditions with temperatures ranging from 36 to 73.5°F (43-73.5°F for Raja, 36-73°F for Ellie, and 42-73°F for Rani and Sri). There was no significant correlation between the percent of time spent in stereotypic behaviour and the ambient temperature [Raja, $R^2=0.00104$ (n= 15); Ellie, $R^2=0.18128$ (n=8); Rani, $R^2=0.02316$ (n=7); and Sri, $R^2=0.2339$ (n=10)].

Effects of crowd size on stereotypic behaviour

Raja, Sri and Ellie all spent significantly more time in stereotypy with low crowds compared with high crowds (Raja, paired difference test, $p=0.011$; Sri, paired difference test, $p=6 \times 10^{-6}$; Ellie, paired difference test, $p=2 \times 10^{-8}$). There was no statistical difference between small and large crowd sizes for Rani and Pearl.

Effects of crowd size on use of space

Elephants did not use the space in the large enclosure (1442.49 m^2) evenly (Chi-square Goodness of Fit test value= 7.89, p-value = 0.005) and avoided the front area. They spent even less time at the front of the enclosure when there were large crowd sizes (Fig. 4).

Location within the small enclosure (693.25 m^2) was designated as "front" and "back", occupying 47% and 53% of the enclosure. There was no significant difference in the time spent at the

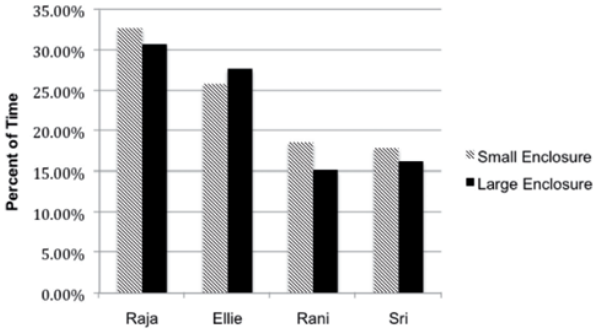

Figure 3. Percentages of time elephants engaged in stereotypy in two enclosure types.

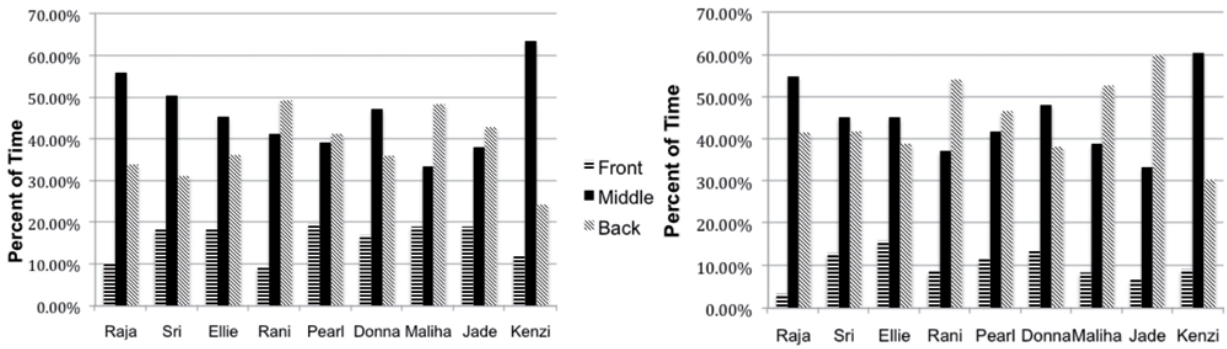

Figure 4. Time elephants spent in different parts of the large enclosure with a small crowd (left) and a large crowd (right) watching.

front and back of the small enclosure (Chi-Square Goodness of Fit test value=1.35, p-value = 0.245) regardless of crowd size (Fig. 5). Kenzi was not included in this analysis because she was not present for the initial 40 hours of observation conducted in 2011.

Discussion

Stereotypic behaviours

This study found higher levels of stereotypic behaviour in four out of six adult elephants at the St. Louis Zoo, compared to de Mel *et al*. (2013), who found 11.53%, 4.45% and 0.93% of behaviours to be stereotypic at three institutions holding captive elephants in Sri Lanka. However, overall stereotypic behaviour exhibited was less than the 45% observed by Gruber *et al*. (2000) in circus elephants. Raja, the male elephant, exhibited the greatest amount of stereotypic behaviour and was the only elephant to display stereotypic pacing. He was the only elephant that was housed alone. All other elephants were kept in groups of three to six. Novak *et al*. (2006) found social isolation was related to more stress and increased stereotypic behaviours in primates. Although a sample size of one precludes definitive conclusions, our results are consistent with such a view and supports management of elephants as social groups and providing greater behavioural enrichment for individually housed elephants.

Gruber *et al*. (2000) studied chained circus elephants and found that restraint was more restrictive for the younger elephants and this resulted in increased stereotypic behaviour in them. In contrast, Rees (2004) found older elephants displayed more stereotypic behaviour. Contrary to Gruber *et al*. (2000) and similar to Rees (2004), in our study stereotypic behaviour was more prevalent in the older elephants and the three youngest displayed no stereotypy at all. The difference between our study and Gruber *et al*. (2000) could be a result of the different environments the elephants were subjected to.

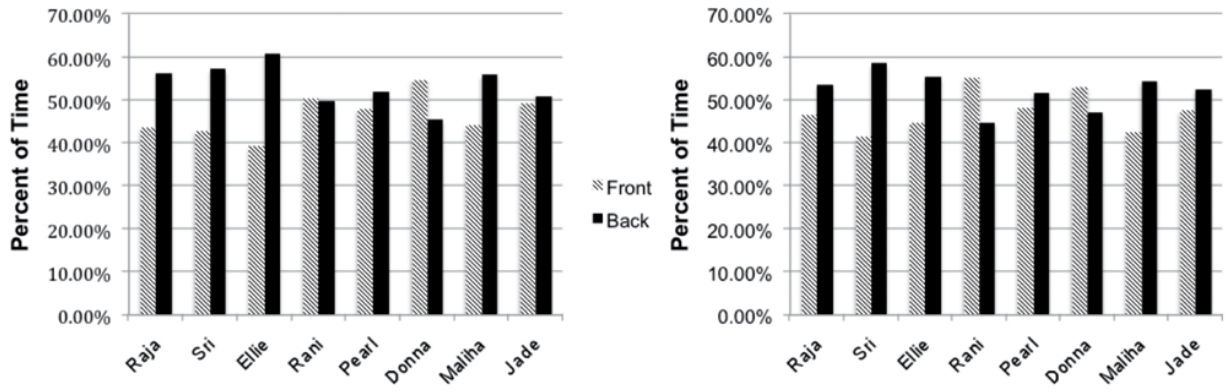

Figure 5. Time elephants spent in different parts of the small enclosure with a small crowd (left) and a large crowd (right) watching.

Mason *et al*. (2007) suggest that providing enrichment and a stimulating environment at a young age could prevent stereotypy later. It would be interesting to follow the levels of stereotypy exhibited by the young elephants at the St. Louis Zoo over time given their particular environment and enrichment.

There was no difference in stereotypy between the small and large enclosures. This suggests that space alone is not sufficient enrichment to avoid stereotypy. This finding is consistent with Lyons *et al*. (1997) who found no difference in pacing behaviour of captive felids in different sized enclosures.

Contrary to Rees (2004) we did not find a relationship between temperature and stereotypic behaviour. The range of temperature at which our elephants were observed was between 36°F and 73.5°F, and Rees compared stereotypy between 39.74°F and 82.4°F.

This study provides evidence that there are behavioural differences in elephants with small and large audience sizes. Hosey (2000) suggests three hypotheses to explain the visitor effect on animal behaviour: visitors effect social facilitation, visitors induce stress, and visitors serve as enrichment. Various studies support the hypothesis that visitors induce stress (Chamove *et al*. 1988; Birke 2002; Wells 2005). Our study showed that there was a decrease in stereotypic behaviour with an increased audience size. Although studies have suggested that stereotypes may serve as a coping mechanism (Mason 2006; Rushen & Mason 2006), a large body of literature has also shown that various causal factors are related to stress, including deprivation (Rushen & Mason 2006). More specifically, it has been found that environments that induce more stereotypic behaviour have poor animal welfare on many axes (Rushen & Mason 2006). The decreased amount of stereotypic behaviour with larger crowd sizes observed in our study suggests that passive human interaction is not related to stress, deprivation, and other similar causal factors. Rather, large crowd sizes are more consistent with the hypothesis that human visitors serve as a source of enrichment.

The audience at the St. Louis Zoo does not directly interact with the elephants. Still, passive audience presence was related to decreased stereotypy. It is possible that the presence of passive, novel stimuli distract the elephants from the processes that motivate stereotypic behaviour. Previous studies have shown positive behavioural responses with active, positive interaction with humans. Shared physical activities with humans such as stroking were associated with more positive behavioural responses in zoo animals (Claxton 2011). It would be interesting to determine whether more frequent keeper interaction or more direct audience interaction would further decrease stereotypic behaviours.

Although much of the current research shows that zoo visitors are a source of stress for primates, this does not seem to be the case for captive elephants. Their zoo environment and visitor interaction are very different from primates'. The elephant-viewing exhibit was completely outdoors, which prevents amplification of noise from a large audience. In contrast, many primate exhibits are both indoor and outdoor. Crowd noise could be more problematic in an indoor setting.

Ellie was an interesting case. She exhibited significantly more stereotypy in 2012 compared with 2011. During observation in 2011, Ellie was in the late stages of pregnancy and was expected to give birth in the summer of that year. In 2012, she was usually housed with other females, including her new daughter, Kenzi. Factors such as the changes in housing situation and

Figure 6. Elephant at St. Louis Zoo (photo by Christa Baker).

companions could explain her change in level of stereotypy between the two years.

Use of space

All elephants, regardless of crowd size, spent the least amount of time at the front of the large enclosure, closest to the crowds. Elephants used both front and rear of the smaller enclosure, regardless of crowd size. The elephants' use of space and similar frequencies of stereotypic behaviour in the small and large enclosures provide additional evidence that space alone is not a key factor in the wellbeing of captive elephants. It is important to note that the smaller enclosure had a rock formation that allowed the elephants to be out of view from the public even while at the front of the enclosure. In contrast, the large enclosure did not have any barriers to visually block the crowds. Its expansive and relatively open structure might actually be an unintentionally aversive environment. Our results showed that larger enclosures do not result in more use of space. Rather, additional enrichment factors need to be further studied in order to determine why some spaces are used more than others.

These findings are similar to Mallapur *et al*. (2002) who looked at enclosure design and space use by leopards at various zoos in southern India. They found that there was no difference in stereotypic behaviour between "enriched" and "barren" enclosures. However, activity levels were higher in the enriched enclosures. In addition, they found that the edges of the enclosure were used more frequently, and that leopards exhibited the majority of their stereotypic behaviour at the edges of the enclosures (Mallapur *et al*. 2002). These results also support the idea that larger exhibits are not necessarily better exhibits if the animals do not use all of the space.

Acknowledgements

Many thanks to Dr. Robert Sussman for help with observational tools and experimental design. Thanks also to the St. Louis Zoo for providing veterinary data on the individual elephants and details of their daily care.

References

Anderson US, Benne M, Bloomsmith MA & Maple TL (2002) Retreat space and human visitor density moderate undesirable behavior in petting zoo animals. *Journal of Applied Animal Welfare Science* **5:** 125-137.

Birke L (2002) Effects of browse, human visitors and noise on the behaviour of captive orangutans. *Animal Welfare* **11:** 189-202.

Chamove AS, Hosey GR & Schaetzel P (1988) Visitors Excite Primates in Zoos. *Zoo Biology* **7:** 359-369.

Claxton AM (2011) The potential of the human-animal relationship as an environmental enrichment for the welfare of zoo-housed animals. *Appl. Animal Behav. Science* **133:** 1-10.

Clubb R & Mason G (2002) *A Review of the Welfare of Zoo Elephants in Europe*. Report by RSPCA.

de Mel RK, Weerakoon DK & Ratnasooriya WD (2013) A comparison of stereotypic behaviour in Asian elephants at three different institutions in Sri Lanka. *Gajah* **38:** 25-29.

Elzanowski A & Sergiel A (2006) Stereotypic behavior of a female Asiatic elephant (*Elephas maximus*) in a zoo. *Journal of Applied Animal Welfare Science* **9:** 223-32.

Fernandez EJ, Tamborski MA, Pickens SR & Timberlake W (2009) Animal-visitor interactions in the modern zoo: conflicts and interventions. *Applied Animal Behaviour Science* **120:** 1-8.

Gruber TM, Friend TH, Gardner JM, Packard JM, Beaver B & Bushong D (2000) Variation in stereotypic behavior related to restraint in circus elephants. *Zoo Biology* **19:** 209-21.

Hildebrandt TB, Goritz F, Hermes R, Reid C, Denhard M & Brown JL (2006) Aspects of the reproductive biology and breeding management of Asian and African elephants. *Elephants and Rhinoceros* **40:** 20-40.

Hosey GR (2000) Zoo animals and their human audiences: What is the visitor effect? *Animal Welfare* **9:** 343-357.

Hutchins M (2006) Variation in nature: its implications for zoo elephant management. *Zoo Biology* **25:** 161-171.

Koolhaas JM, Korte SM, De Boer SF, Van Der Vegt BJ, Van Reenen CG, Hopster H, De Jong IC, Ruis MAW & Blokhuis HJ (1999) Coping styles in animals: Current status in behavior and stress-physiology. *Neuroscience and Biobehavioral Reviews* **23:** 925-935.

Kuhar CW (2008) Group differences in captive gorillas' reaction to large crowds. *Applied Animal Behaviour Science* **110:** 377-385.

Kumar MA & Singh M (2010) Behavior of Asian elephant (*Elephas maximus*) in a land-use mosaic: conservation implications for human-elephant coexistence in the Anamalai Hills, India. *Wildlife Biology in Practice* **6(2):** 69-80.

Lyons J, Young RJ & Deag JM (1997) The effects of physical characteristics of the environment and feeding regime on the behavior of captive felids. *Zoo Biology* **16:** 71-83.

Mallapur A, Qureshi Q & Chellam R (2002) Enclosure design and space utilization by Indian leopards (*Panthera pardus*) in four zoos in southern India. *Journal of Applied Animal Welfare Science* **5:** 111-124.

Mason G (2006) Stereotypic behavior in captive animals: Fundamentals and implications for welfare and beyond. In: *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*. Mason G & Rushen J (eds) Cromwell Press, London, UK. pp 325-356.

Mason G, Clubb R, Lantham N & Vickery S (2007) Why and how should we use environmental enrichment to tackle stereotypic behaviour? *Appl. Animal Behaviour Science* **102:** 163-188.

Mason GA & Veasey JS (2010) How should the psychological well-being of zoo elephants be objectively investigated? *Zoo Biol*. **29:** 237-255.

Nimon AJ & Dalziel FR (1992) Cross-species interaction and communication: a study method applied to captive siamang (*Hylobates syndactylus*) and long-billed corella (*Cacatua tenuirostris*) contacts with humans. *Applied Animal Behaviour Science* **33:** 261-272.

Novak MA, Meyer JS, Lutz C & Tiefenbacher S (2006) Deprived environments: Developmental insights from primatology. In: *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*. Mason G & Rushen J (eds) Cromwell Press, London, UK. pp 153-189.

Rees PA (2004) Low environmental temperature causes an increase in stereotypic behaviour in captive Asian elephants (*Elephas maximus*). *Journal of Thermal Biology* **29:** 37-43.

Rushen J & Mason G (2006) A decade-or-more's progress in understanding stereotypic behavior. In: *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*. Mason G & Rushen J (eds) Cromwell Press, London, UK. pp 1-18.

Wells DL (2005) A note on the influence of visitors on the behavior and welfare of zoo-housed gorillas. *Applied Animal Behaviour Science* **93:** 13-17.

Figure 7. Baby elephant at St. Louis Zoo (photo by Christa Baker).