

# Effects of environmental enrichment techniques on stereotypical behaviours of captive Sumatran tigers: A preliminary case study

Diana Gomes<sup>■</sup> ▪ Lynda McSweeney<sup>■</sup> ▪ Mário Santos<sup>■</sup> 

**D Gomes<sup>A</sup>** (Corresponding author) ▪ **L McSweeney<sup>B</sup>** ▪ **M Santos<sup>A,C</sup>**

<sup>A</sup>Laboratory of Applied Ecology, CITAB - Centre for the Research and Technology of Agro-Environment and Biological Sciences, Universidade de Trás-os-Montes e Alto Douro, 5000-911, Vila Real, Portugal.  
email: dianainesgomes@gmail.com

<sup>B</sup>Education Complex, Fota Wildlife Park, Carrigtwohill, Co. Cork, Ireland.

<sup>C</sup>Laboratory of Ecology and Conservation, Federal Institute of Education, Science and Technology of Maranhão, R. Dep. Gastão Vieira, 1000, 65393-000 Buriticupu, MA, Brazil.

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**Abstract** Wild animals are maintained in Zoological facilities for purposes of education, conservation, research, and recreation. Several studies have proven that the surroundings of an animal's artificial habitat, as well as environmental enrichment techniques, are factors that influence behaviour and have an impact on animals' welfare. In the present work carried out at Fota Wildlife Park, Cork, Republic of Ireland, we observed and collected information concerning three Sumatran Tigers (*Panthera tigris sumatrae*). The research achievements, registered on an ethogram, seem to demonstrate a link between the enclosure features and the environmental enrichment techniques applied with the stereotypical behaviours directly observed. In fact, the obtained results show that the characteristics of the enclosures were a determining factor on the tiger's behaviour. The obtained results also depict and highlight the extreme relevance of individual ethos when choosing the environmental enrichment techniques applied in order to reduce stereotypical behaviours observed in the captive tigers.

**Keywords:** animal welfare, *Panthera tigris sumatrae*, atress, Zoo

## Introduction

The Sumatran tiger, *Panthera tigris sumatrae*, is classified by the IUCN as Critically Endangered since 1996. It is estimated that there are fewer than 400 individuals in the wild, which makes this small wild population a priority endemic subspecies to be conserved (Linkie et al 2008). The main threats to the subspecies are poaching and habitat loss, reasons why individuals are commonly found in captive environments (Shepherd and Magnus 2004; Wibisono and Pusparini 2010). Ex-situ conservation involves the protection of all components of biodiversity outside their natural habitats

and it is of major importance for endangered specimens, since their future existence is, in many ways, dependent on human intervention and support through captive management strategies (Dehnhard et al 2008). Guaranteeing animal welfare is crucial in a captive environment and, to ensure that, observing and understanding the behavioural signs that can indicate if the welfare displayed is of poor or high quality is fundamental (Veasey et al 1996). Experts introduced several environmental enrichment techniques to help control abnormal behaviours in captivity (Pitsko 2003; Pizzutto et al 2009; Swaisgood and Shepherdson 2005). This short note was aimed at assessing possible associations between enclosure features and environmental enrichment techniques with stereotypical behaviours of captive Sumatran tigers.

## Materials and Methods

The research study was conducted at Fota Wildlife Park (Cork, Republic of Ireland), after careful observation of the behaviour of three adult Sumatran tigers (♂, ♀), with the purpose of finding possible influences of the enclosure features and implications of the application of environmental enrichment techniques on the animal's stereotypical behaviours. The tigers rotated within three separated enclosures (named B, C and D). Enclosures varied in size and were equipped with different features and vegetation. Each enclosure had a grassland substrate, a water supply, shaded areas, and hiding spots, offering the animals the opportunity to stay away from visitors' eye-contact. Enclosure B and D also contained high resting spots. Enclosure C was also adjoining a road with considerable movement during the day (Figure 1).

We used two periods to monitor behaviours – an hour during the morning and another in the afternoon. We observed each animal for 40 minutes a day, totalling 254 observation

hours in 127 days (only 14 of those days were included on the environmental enrichment techniques data collection). We built our ethogram using tiger behavioural patterns in the wild as a baseline. The goal was to record the information necessary to answer two questions: “Are there holistic relations between the environment and the animal’s stereotypical behaviours?” and “Do environmental enrichment techniques reduce the animal stress, namely by decreasing the percentage of stereotypical behaviours demonstrated?”.

The Scheirer-Ray-Hare test (extension of the Kruskal-Wallis test, non-parametric equivalent to the multifactorial ANOVA correlation test), the Kruskal-Wallis test and the Spearman’s Rank Correlation test (Sokal and Rolfh 2012), were used to verify the possible connections between the percentage of stereotypical behaviours observed, the enclosure features and the effects of the implementation of environmental enrichment techniques.

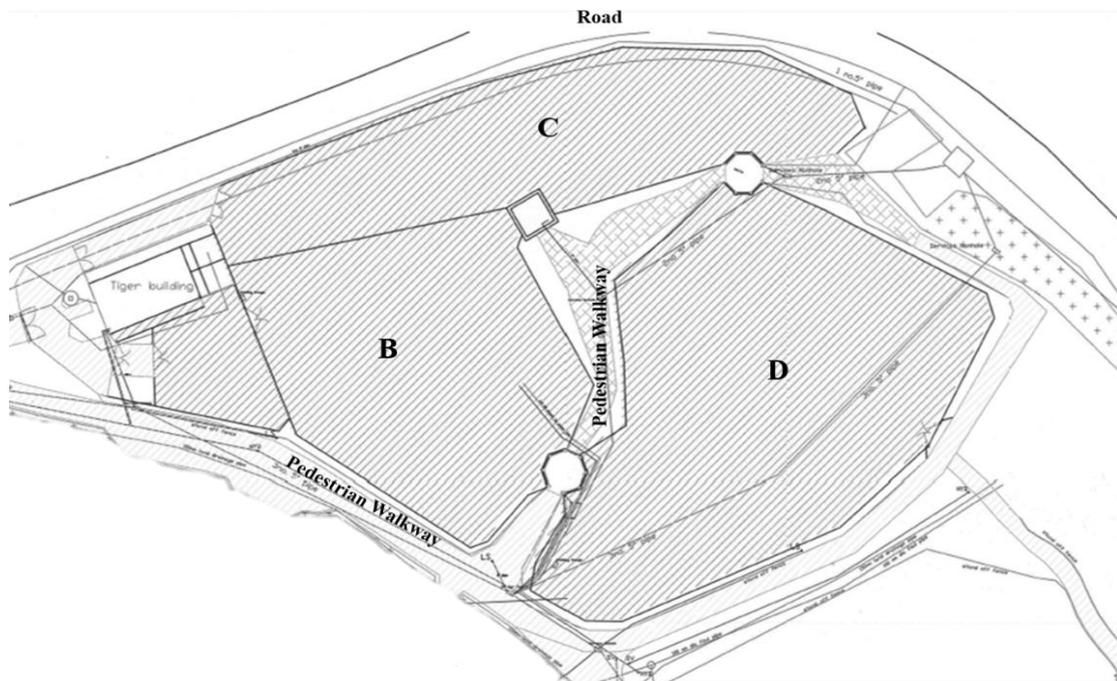


Figure 1 Fota Wildlife Park tiger’s enclosure architecture design.

**Results and Discussion**

The results from the Scheirer-Ray-Hare test (Table 1) show that there is a significant interaction between the enclosure and tigers (although with significant results also for each factor independently).

**Table 1** Three-way Scheirer-Ray-Hare extension of the Kruskal-Wallis test for the stereotypical behaviours displayed by the three tigers in three enclosures. Degrees of freedom (df), Sum-of-Squares (SS), Kruskal-Wallis value ( $X^2$ ) and associated significance (\*\* $P < 0.001$ ; \*\* $P < 0.01$ ).

Variables	SS	df	$X^2$
Enclosure	99844	2	13.816 (***)
Tiger	76039	2	9.210 (**)
Interaction	174366	4	18.467 (***)
Error	2066170	350	
SStotal	2416419		
MStotal	6749.774		

By applying the Kruskal-Wallis test to each individual separately by enclosure, it was possible to observe the stereotypical behaviours variations with detail (Table 2). The Box and Whisker plots (Figure 2) highlight the results of table 2: Tiger 2, when placed in enclosure C, significantly increases its stereotypical behaviours, while the two other conspecifics remain unchanged.

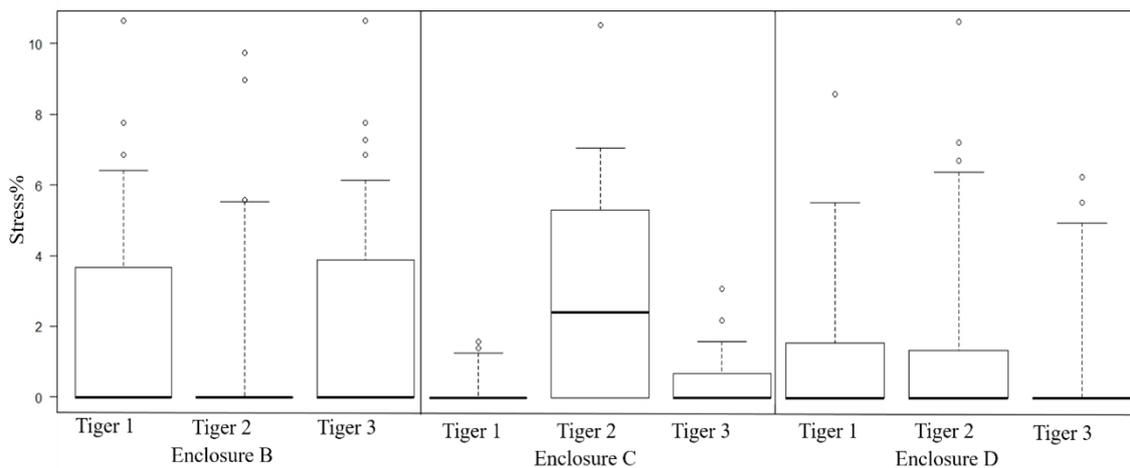
A Spearman’s Rank Correlation test (Figure 3) was used to analyse if there were changes in the animal’s stereotypical behaviours when environmental enrichment techniques were present. The analysis showed a significant and negative correlation, between the number of environmental enrichment techniques available for each tiger and stereotypical behaviours displayed ( $Sp = 0.23$ ;  $P < 0.001$ ).

**Table 2** Kruskal-Wallis test (KW) for the stereotypical behaviours displayed by tiger (1, 2 and 3) in the three enclosures (B, C, D). Kruskal-Wallis value ( $X^2$ ), and associated significance ( $***P < 0.001$ ; n.s., non-significant), Degrees of freedom (df) and medians of stereotypical behaviours by enclosure.

Enclosure	Tigers								
	1			2			3		
	$X^2$	df	Medians (B,C,D)	$X^2$	df	Medians (B,C,D)	$X^2$	df	Medians (B,C,D)
KW	0.473 (n.s)	2	(0,0,0)	32.953 (***)	2	(0,11.6,0)	3.551 (n.s.)	2	(0,0,0)

Our work seems to demonstrate that there is a significant interaction between the animals and the enclosures, highlighting the importance of considering the individual ethos when managing individuals of this species. In fact, only tiger 2, the oldest male, when placed in enclosure C, revealed differences in the stereotypical behaviours by significantly increasing their percentage. Actually, tiger 2 showed aggressiveness towards humans, noises, other animals (except for the other two tigers), cars or new objects. This was exacerbated when Tiger 2 was located in enclosure C, which was close to one of the park roads giving access to the park's

coffee shop. The same road also connects Fota Island train station to all the other surrounding areas (Fota Hotel, Gardens and House) so, there are many passers-by jogging or walking their pets. Moreover, enclosure C lacks high points, and it has less angular ground or landform variations, which can also be influencing tiger 2 behaviour patterns. The other two tigers did not demonstrate the "nervous" behaviours revealed by tiger 2: tiger 1, a young male, was always very energetic and curious, and stereotypical behaviours were rarely observed in him. Tiger 3, a female, was also rarely observed displaying stereotypical behaviours.



**Figure 2** Box and Whisker plots presenting the results from the Scheirer-Ray-Hare extension of the Kruskal-Wallis test concerning the relation between the individuals, the enclosures they were in and the percentage of Stress they demonstrate in each enclosure. (N= 360). Medians: Enclosure B - Tiger 1 = 0, Tiger 2 = 0, Tiger 3 = 0; Enclosure C - Tiger 1 = 0, Tiger 2 = 11,6, Tiger 3 = 0; ; Enclosure D - Tiger 1 = 0, Tiger 2 = 0, Tiger 3 = 0. Created with "R x64 3.3.2".

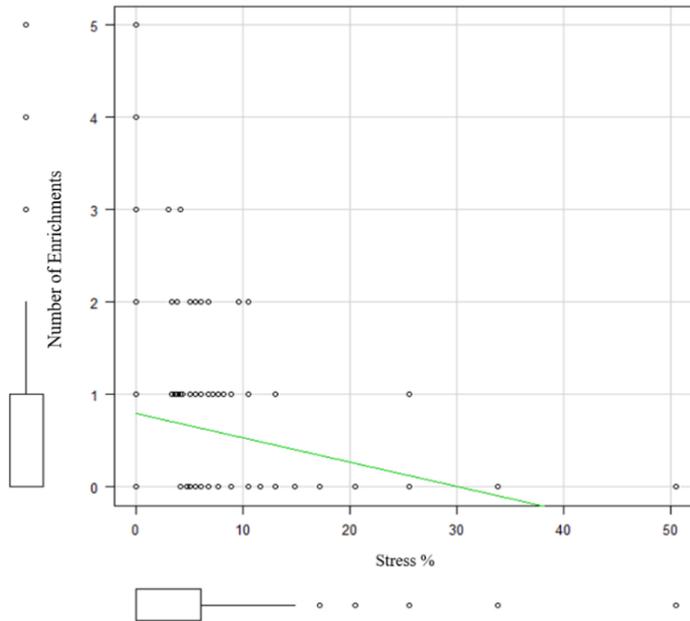
The results of the enrichment study reveal that the more environmental enrichment techniques provided, the less stereotypical behaviours are expected to be observed. Hoy (2009) reminds that environmental enrichment techniques are time expending activities and that, sometimes, it is very difficult for the keepers to find enough time to dispend imagining, constructing and implementing those techniques. Because of this, most of the times environmental enrichment techniques don't have as much quantity, variety, frequency and evaluation as they should to guarantee an optimum welfare. Pistosko (2003) made a study related to the enclosure

features, concluding that more naturalistic enclosure provides higher stimuli, reducing inactivity and pacing. The author emphasizes the importance of providing high shaded hiding places for the animals to rest, a water body, and natural substrate/ vegetation, as well as enough space for the animals to run and perform exploratory behaviours. Toys (ball, boxes), and diversified types of food presentation (intact carcasses, ice blood) were also considered fundamental by the same author. Skibieli (2007) and Lyons (1997) relate food and olfactory environmental enrichment techniques with a decline of stereotypical behaviours display. Silva (2004) and Walzer

(1997) defend that environmental enrichment stimulates animals to display more varied and “natural” behaviours, having a superior use of space and performing less pacing.

The purpose of this study was to investigate if and how the enclosure features and application of environmental enrichment techniques may affect behaviours of zoo-housed Sumatran Tigers (*Panthera tigris sumatrae*). We agree with

several authors who argue that diminished environmental complexity is linked to stereotypies in animals (Morgan and Tromborg 2007; Pitsko 2003; Pizzutto et al 2009; Roesch 2003; Silva 2004), but we also highlight that the individual ethos should be considered a significant aspect when managing individuals of this species in zoos.



**Figure 3** Result from the Spearman’s Rank Correlation test measuring the correlation between the amount of enrichment items provided and the stress%. (N= 360). Created with “R x64 3.3.2”.

**Conclusions**

Understanding the way captive animals are affected by their surroundings is essential to guarantee their good welfare. The ability to perceive alterations on an animal’s behaviour and the source of that change is vital to ensure modern zoological facility goals – provide qualified animal welfare, conservation and education. To achieve this purpose, we urge for deeper research and studies about captive animal’s behaviour and all their derivate. This study, regardless the small size of the sampling group, allowed the acquisition of more detailed information about how some captive environment dynamics affected the tiger group hosted in Fota Wildlife Park. The results accomplished in the course of this study revealed some interesting aspects about the group’s welfare, such as: the enclosure design has an extremely important influence on Sumatran tigers’ behaviour; it is very possible that the animal’s ethos also has a major influence on the reactive response to stress features, based on the different reactions they display when in one same enclosure; that enrichment techniques are an enormous added value to the animals, significantly reducing stereotypical behaviours.

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