

How Does Captivity Impact Psychological Behaviors On Large Carnivores, And To What Extent Can Environmental Enrichment Bring Reduction Of These Effects In Modern Zoos?

By Irene Han, Esther Kim

AUTHOR BIO

Esther Kim, a senior at Korea International School, has a keen interest in psychology and international studies and hopes to work as a UX researcher or for an NGO. In order to investigate the psychological effects of animal captivity and how it affects behavior, she wrote this paper as a club project. Throughout high school, Esther has been an active member of Spectra. Outside of the club, she is also involved with an organization that conducts interviews with foreign ambassadors. Her academic and extracurricular endeavors are motivated by her passion for comprehending the psychological processes of both humans and animals, and she intends to carry on researching these areas in the future.

Irene Han is a junior at Korea International School and has a deep interest for animals and their welfare. She intends to continue her education in this field as she wants to become a veterinarian. Irene combined her partner's and her own interests to write this paper for a school research club project. She investigates methods to lessen the stress of captive animals and focuses on their behavior. Irene volunteers at animal shelters and conducts her own independent research on different species and their behaviors in addition to her work in the club. Through upcoming studies and research, she intends to continue expanding her knowledge of animals.

ABSTRACT

This study aims to critically evaluate enrichment strategies for large carnivores in captivity through a literature review. Common stereotypic behaviors indicating high stress level for large carnivores were identified: pacing and bar biting etc. High stress levels came from the small enclosures of the cage, lack of environmental complexity and stimulus, social isolation, and negative keeper attitudes¹ (Vaz et al., 2017; Birke et al., 2019; Yasmeeen et al., 2022). Studies reviewed demonstrated that both naturalistic enclosures (covering enclosure with stones, trees, placing pools) and sensory enrichment (e.g, food or smell of prey) were factors for significant reduction in stereotypic behaviors. These factors reduced 12% of stereotypic behaviors for tigers² (Vaz et al., 2017) to 40% in lions³ (Khan, 2025). Other factors also contributing to reduction of stressful behavior that was studied include physical enrichment, which can be achieved through giving enough exercise to help the carnivores use the amount of energy they would use for hunting and moving in their natural habitat.⁴ (de Azevedo et al., 2023; Smith et al., 2022) These enrichment strategies help improve the welfare of large carnivores outside of their natural habitat. These strategies can be adapted in zoo management practices to foster healthier environments for captive carnivores and promote positive zoo culture.

INTRODUCTION

Large Carnivores, referring to big mammalian predators such as wolves, and bears, are an attraction of Zoos. Seeing a tertiary consumer locked up behind glass windows and iron bars are only a few ways to observe these canine teeth without getting harmed. But holding captive animals (in zoos, sanctuaries, research facilities) that usually roam around large territories, bring side effects. Referred to as stereotypic behaviors, such as pacing, head-bobbing, and over grooming, these indicate animals are stressed and under high psychological pressure.⁵ (Clubb & Mason, 2003; Yasmeen et al., 2022) Captive environments not only lack enough space for these animals, but boredom from absence of challenge and social interaction or stress from the loud visitors are also reasons behind these behaviours.⁶ (Lee et al., 2022; Miller et al., 2021) After the emergence of Animal Psychology after the 19th century, ethologists have realized the stress captive environments cause to the animals and have been developing enrichment strategies. After the difference between stereotypic and normal behaviors are observed and quantified, specific environmental enrichment interventions can be placed, closely monitoring the carnivores for reduction of stereotypical behaviors and further positive change.⁷ (de Azevedo et al., 2023; Fernandez, 2022)

METHODOLOGY

Design and Approach

This research has a non experimental approach, relying on a scoping review of existing studies on captive large carnivores. The study focuses on understanding the common behaviors that these predators display as well as mitigation strategies for these behaviors. As this study aims to broadly map out research in this

field and highlight consistent patterns in findings, a scoping review was specifically chosen.

Data Collection

In identifying sources for this literature review, multiple databases were used. This literature review is built off of findings from various research papers that focus on the study of repetitive behaviors of large carnivores. A total of approximately twenty peer-reviewed papers were selected. These were chosen because they addressed stereotypic or repetitive behaviors in zoo-housed animals, explored the environmental or social factors influencing these behaviors, or evaluated enrichment strategies intended to mitigate them. Through many articles, papers, and other peer-reviewed journals the data for this research was amassed..

Analysis

The gathered data and studies were reviewed and categorized to identify such findings on the causes of stereotypic behaviors in large carnivores. Some aspects that were accentuated were the types of stereotypic behaviors observed in different carnivore species, the environmental and social factors contributing to these behaviors and the effectiveness of enrichment interventions (e.g., feeding puzzles, expanded enclosures, sensory enrichment, and social housing). The findings were composed and compared across numerous studies to highlight consistent patterns and discrepancies. This comparative approach allowed for a critical evaluation of the effectiveness of enrichment strategies and the overall welfare of large carnivores in captivity.

DISCUSSIONS & RESULTS

Results

Reviewing more than 20 research articles, large carnivores including Tigers and Lions were observed in multiple different conditions. The studies consistently examined how enrichment influenced animal welfare by reducing stereotypic behaviors; With feeding, sensory, and physical enrichment being the most common categories⁸ (Fernandez, 2022; Koosis, 2025). There were also several cases where multiple enrichment strategies were combined to yield stronger outcomes. For example, in Vaz et al. (2017)⁹, 12% of Tigers and 7% of Leopards were observed with stereotypic behaviors, such as pacing and bar-biting, during daylight hours. Contributing to these stereotypic behaviors included Small/simple enclosures and lack of complexity. Similarly, Smith et al.(2022)¹⁰, reported that social isolation and negative keeper attitude were key contributors to stereotypic behavior on carnivores. Khan's (2025)¹¹ study identified similar factors such as small/concrete enclosures, lack of natural habitat. All studies identified at least one captivity factor contributing to stereotypic behaviors.

Taken together, all studies reviewed identified at least one captivity-related factor that contributed to stereotypic behaviors. Lack of naturalistic features (pools, logs, vegetation), minimal space, hostile keeper attitudes were the most commonly mentioned factors. Furthermore, although the percentage of animals showing stereotypic behavior varied for different studies, stereotypic behaviors were present in a significant proportion of zoo-housed carnivores, often exceeding 50% in some populations (Khan, 2025)¹²

Discussion

Interpreting these results helps achieve the broader goal of identifying enrichment strategies that can effectively reduce stereotypic behaviors in large carnivores. One solution multiple research articles approached was to provide the enclosed space with pools, stones and tree cover to five more naturalistic enclosures. One approach supported across multiple studies was naturalistic enrichment-modifying enclosures to more closely resemble wild habitat. For instance, Vaz et al. (2017), reduced tigers' stereotypic behavior of pacing and bar biting etc. up to 12% by introducing pools, stones, and tree cover into the tigers' enclosures.¹³ This suggests that environmental modifications for zoos not only reduce stress but also stimulate species-typical activities to increase physical activities.

Additionally, Khan's study used sensory enrichment strategies for Lions- providing them with Catnip, prey dung.¹⁴ This reduced 40% of the Lions' stereotypic behavior of pacing. Using these data results, zoos can follow these study results and give naturalistic enclosures, which is included in visual enrichment strategy and also sensory enrichment strategies to reduce stressful behavior on large carnivores living in captivity. This highlights that stimulating an animal's sensory, which is often absent in sterile environments, can significantly improve animal welfare.

Feeding enrichment was also mentioned in studies and emerged to be a powerful enrichment strategy. Studies emphasized that scattering meat encouraged animals to participate in natural foraging and hunting-like activities. Smith et al. (2022) did a study with lions where lions exposed to feeding enrichment spent more time engaging in the hunting activities and less time showing stereotypic behaviors.¹⁵ This reinforces the idea that not

only should enrichment strategies provide a distraction or create a nature-like effect but should mimic natural ecological challenges.

Naturally, some enrichment strategies resulted to be more effective for certain species than others. For example, tigers respond strongly to naturalistic environmental enrichment and provide them with enough physical activities including swimming or tree climbing.¹⁶(Smith et al., 2022) On the other hand, lions showed greater reduction in stress-related pacing when sensory enrichment, such as smelling catnip, was applied¹⁷.(Rose, P. E., et al.2017) These study results suggest that enrichment strategies should be tailored to the niche behavioral ecology of each species.

Despite the promising results, several limitations exist. Many studies reviewed had small sample sizes (often fewer than 10 animals), and even had a switch of participating animals due to factors like mating seasons or illness. Additionally, some cases had shorter duration of the interventions, raising questions about the long-term effect of enrichment strategies. Furthermore, some studies neglected to measure both behavior and physiological outcomes, unable to confirm whether the observed improvements were to the enrichment planning or simply due to outside factors (e.g. hormonal change).¹⁸(de Azevedo, C. S., et al. 2023) This gap in the literature is a limitation to make definitive conclusions about the credibility of the enrichment strategies.

CONCLUSION

Multiple studies conclude that enrichment strategies are effective up to at most 40% for large carnivores. In one study over 80% of tigers included in the study had stereotypic behaviors.¹⁹(Vaz, J., et al. 2017) Therefore, by applying sensory, feeding, and physical enrichment strategies, more zoos can provide a

healthy relationship between the visitors and the animals.

By introducing enrichment strategies to zoos, visitors can observe animals engaging in natural behaviors rather than seeing them pacing and bobbing their heads- stress indicators that can lead to negative perception of the zoo. Adaptation of the enrichment program can help the zoos shift people's view from places of confinement to a space that prioritizes the wellbeing of its animals.²⁰ (Koosis, A. 2025) This can provide a healthy relationship and zoo culture between the zoos and the public, fostering greater support for conservation efforts.

In order to establish long-term impacts of enrichment, especially to larger variations of carnivore species, more research will need to be done. Future studies should also focus on integrating both behavioral and physiological measures into the study to get clearer results that could indicate the success of the study.

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