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Animal Care

Assessing the welfare implications of training participation in captive felids

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Abstract

With the global decline of wild felid populations, zoos play an increasingly vital role in conservation efforts. However, maintaining high welfare standards for captive felids remains a significant challenge, as individuals often display chronic stress, stereotypic behaviours, and fear-based responses to human interaction. This study investigated the potential of structured training methods, specifically target training and keeper habituation, to serve as non-invasive behavioural indicators of welfare in three captive felid species.

Target training was implemented as a method of positive reinforcement, where animals were conditioned to follow or touch a designated object in exchange for a reward. Keeper habituation involved a gradual progression from passive visual exposure to close-proximity interaction, using techniques such as desensitization and counterconditioning to reduce fear and promote trust.

Behavioural observations were recorded using species-specific ethograms and were quantitatively scored by both a researcher and trained animal keepers. Statistical analysis was conducted using RStudio, with descriptive quantitative scoring of willingness to participate and graphical analyses were used to examine the relationship between training participation and behavioural welfare indicators. Data visualization techniques were also applied to illustrate behavioural changes over time.

The results indicated that increased engagement in training sessions was associated with greater behavioural diversity and a decrease in negative behaviors such as stereotypy and agonism. These findings suggest that observable behavioural responses to training reflects enhanced psychological well-being and may serve as a practical and non-invasive tool for welfare assessment in captive felids.

1. Introduction

1.1 Overview of Felidae

Felidae is a family of mammals in the order carnivora commonly referred to as cats. Members of this family are called felids. All felids are thought to be ancestors of *Proailurus*. There are 3 recognizable subfamilies with 2 subfamilies extant currently. These include Pantherinae, Felinae while Machairodontinae cats are extinct. Subfamily Pantherinae consists of 6 species in 3 genera and Felinae consists of 30 species in 11 genera. Wild felids are native to every continent except Antarctica and Australia. They are found in all terrestrial habitats except treeless tundra and polar ice regions.

The 41 extant felid species show a great diversity in fur patterns. They bear strong resemblance to one another. They have a few morphological modifications and adaptations that has allowed them to become the best hunters in the order Carnivora. They have exceptional vision with large eyes and semi rotating ears. Most cats in the wild do not survive until their 1st birthday due to threats to predation. Their lifespan however, ranges from 15-30 years old. In captivity, the juveniles offer suffer from maternal neglect, hypothermia and congenital disorders.

1.2 Taxonomy, population, distribution and threats

1.2.1 Fishing cat (Prionailurus viverrinus): Status, threats and distribution

The fishing cat (*Prionailurus viverrinus*) belonging to the family Felidae and subfamily Felinae is a medium-sized wild felid native to South and Southeast Asia, adapted to wetland environments and renowned for its aquatic hunting skills. Below is an introduction summarizing its physical characteristics, global population status, and presence in zoos.

The fishing cat is classified as "Vulnerable" on the IUCN Red List due to ongoing habitat loss, particularly the destruction of wetlands, and human conflict. The global population is estimated at fewer than 10,000 mature individuals, though precise numbers remain uncertain due to the cat's elusive nature and the challenging habitats it occupies. Current global estimates suggest that between 3,194 and 7,527 fishing cats (*Prionailurus viverrinus*) remain in the wild, with the majority found in India, Bangladesh, and Sri Lanka. The IUCN Red List previously cited a figure of fewer than 10,000 mature individuals as of 2010, but more recent sources point to the lower range above, reflecting ongoing population declines due to habitat loss and human conflict.

1.2.2 Puma (Puma concolor): Status and distribution

Global estimates for wild puma (*Puma concolor*) populations are inexact due to their vast range and elusive nature, but it is generally believed that there are at least 20,000–25,000 pumas remaining in North

America, with the number in South America remaining unknown. In the early 1990s, Canada was thought to have 3,500–5,000 pumas, and the western United States around 10,000. In Florida, the isolated and
endangered Florida panther subspecies numbers only 100–180 individuals. Overall, the global population is likely to be in the low tens of thousands, but exact figures are lacking due to insufficient data from many parts of their range.
The number of pumas in captivity is estimated to be around 500-1000 individuals with the highest population in North America. Overall, the IUCN red list status for puma is least concern globally. However, some subspecies and regional populations have different statuses such as the Florida panther being classified as endangered.

1.2.3 Tiger (Panthera tigris): Conservation challenges, population and endangered status

According to the global tiger forum, the global wild tiger population is approximately 5,574 individuals as of 2025. India has the largest share with 3600 tigers contributing to 70-75% of the entire global population. There have been multiple breeding programs implemented around the world to maintain genetic diversity and raise awareness but it has not been able to recover the wild population recovery and habitat protection.
According to the IUCN red list, tigers are endangered due to significant decline in its population from habitat loss, poaching and human wildlife conflict. The Sumatran tiger (*Panthera tigris suamtrae)* specifically is known to be critically endangered. An estimate of less than 600 Sumatran tigers are known to live in the wild. However, under captivity there are about 375 tigers under different ex-situ associations such as the European Association of Zoos and Aquariums (EAZA), Zoo and Aquarium Association (ZAA), Association of Zoos and Aquariums (AZA), Japanese Association of Zoos and Aquariums (JAZA), Perhimpunan Kebun Binatang Se-Indonesia (PKBSI)

1.3 Ex-situ conservation

Ex-situ conservation helps in preservation of species outside of their natural habitats. It is a critical strategy for preserving all the wild populations that face severe threats due to habitat loss, poaching, genetic decline, etc. Ex-situ methods offer a controlled and secure environment to maintain and recover populations that could not be recovered within in-situ conservational methods. Ex-situ programs are known to safeguard genetic diversity, facilitate breeding efforts and provide various opportunities for scientific research that can help in the advancement of potential repopulation and reintroduction of the animals into the wild.

1.4 Zoos

Zoos are one of the most leading sites of ex-situ conservations. They provide facilities and resources that are necessary for the care and management of endangered species. For example, conservation of tigers whose global populations have drastically declined due to poaching, habitat fragmentation and human-

wildlife conflict, several breeding programs and conservational efforts have aimed in managing and maintaining their genetic diversity. Within zoo environments, tigers are bred through coordinated international programs which follow strict management protocols to prevent inbreeding and stimulate natural behaviours to maintain the health and welfare of the animals. At zoos, animals are monitored in various aspects such through behavioural research, veterinary care, development of enrichment techniques to promote their physical and psychological well-being. These techniques also inform conservational strategists about wild populations to implement better ideas and techniques to improve their overall welfare. Most zoos engage in public educational campaigns and collaborate with different conservational agencies to raise awareness about threats to wildlife and importance in their conservation. Zoos also act as a rescue center and sanctuary to the animals by providing them a safe environment and protecting them from illegal trade, circuses and conflict zones by providing them better living conditions and a second chance at life.

1.5 Major welfare concerns in felids

1.5.1 Inadequate Enclosure Size and Lack of Space

Often, felids often suffer from insufficient space in zoo enclosures. This restricts their natural movement and behaviours. Typically, zoo enclosures are required to follow certain guidelines for enclosure sizes depending on species and number of animals such as 1200 sq. ft. for a pair of large felids. It is also required to have 50% more space per extra animal. Lack of adequate space often leads to restrictions in movement, exercise and exploration which can lead to frustration and abnormal behaviours.

1.5.2 Lack of Environmental Enrichment and Complexity

Lack of environmental enrichment such as climbing structures, hiding places and varied terrain prevents felids from expressing their natural behaviours like climbing, running and exploring. Enrichments should be capable of improving and stimulating the animal both physically and mentally. Lack of correct enrichment can lead to boredom, induce stress making the animal less active and thus impacting both their physical and psychological health.

1.5.3 Behavioural restrictions/ expression of negative behaviours

Stereotypic behaviors, such as pacing along enclosure boundaries, are common in captive felids and are indicators of poor welfare. These repetitive, purposeless actions often develop in response to inadequate space, lack of stimulation, or inability to perform natural behaviors. Enclosure design can help mitigate these behaviors for example, curved walls discourage pacing compared to straight lines. Persistent stereotypies signal unmet behavioural needs and chronic stress in captive felids. Sometimes disturbances in day-night time behaviours can also be noticed. Display of aggression, self-harm, head tossing, auto mutilation, feces licking, reduction or increase in level of alertness and dragging of paws are some of the other behavioural welfare concerns observed in large felids.

1.5.4 Malnutrition/deprivation of food/deprivation of water

Problems regarding diet and water such as dehydration, obesity, weight loss, anemia, loss of condition and body weight, and vitamin deficiencies are common in captive felids.
Most common warnings issued to zoos from the animal protection act includes poor hygiene protocols, insufficient dietary requirements, lack of shelter, unsatisfactory enclosure designs and lack of treatment.

1.6 Enrichment

Enrichment types used for animals are usually divided into five main categories. Social, cognitive, structure, sensory and food. Any enrichment conditions that involve conspecific interactions are categorized under social. Enrichment conditions that involve problem-solving and exercise are considered cognitive. Those that involve changes in physical habitat, with access to internal and external accessories such as bars and hanging objects are related to structural or physical enrichments. Sensory enrichments involve provision of olfactory, auditory and visual stimuli to animals. Food enrichments involve any type and delivery of food items to animals.
The effect of enrichments is classified into 3 types. An observable and statistically significant increase in desirable responses are positive effects. Observable and statistically significant decrease in desirable responses or increase in undesirable responses are negative effects. Neutral/ Unclear effects are the ones that show no clear behavioural and physiological changes in animals before and after enrichment phase for at least one measure.

1.6.1 Social stimulation as enrichment

Social stimulation enrichment types are the least studied in big cats due to their solitary nature. Wild cats are primarily solitary in nature and only interact for mating purposes and when females' rear cubs. In captive settings tigers are usually housed in pairs or trios. De Rouck et al. (2005) discovered that, pair housed tigers performed a wider variety of behaviours compared to solitarily housed tigers. Contrastingly, Miller and Kuhar (2007) found that over a six-year period, non-contact aggression and vocalization increased, while spraying and social proximity decreased. Bashaw et al. (2007) and De Rouck et al. (2005) found that tigers display more pacing when adjacent to other tigers. Whereas, in smaller felids there are studies that have shown negative effects of social housing like reduction in reproductive success in pair housed animals and higher levels of pacing. Younger tigers such as cubs and sub-adults display higher proportions of interactive behaviours with each other compared to adult tigers.
Human interaction has not been scientifically explored as an enrichment technique, despite it having the potential to be enrichment, both in the form of training and as a husbandry style.

1.6.2 Enrichment targeting natural feeding and hunting behaviours

Most of the documented environmental enrichment efforts have addressed natural hunting and feeding behaviours since their natural instincts in the wild involves hunting and consuming prey. In the wild,

tigers spend a significant energy expenditure to successfully bring down animals such as seizing, pulling, gripping, etc. Since captive feeding techniques do not require natural foraging tactics and energy expenditure, their various physiological and psychological implications are affected such as greater performance of stereotypic behaviour. Enrichment efforts have focused on stimulating natural behaviours and attempting to replicate as much as possible, feeding in the wild. This has been achieved through provision of novel food items such as animal bones, carcasses (whole and partial) and fish to increase behaviours like capturing, mock killing and fur plucking. Often, changes in feeding routines and food provisions in order to replicate the wild where the animals do not hunt daily. This may lead to increase in stereotypic behaviours on non-feeding days. Jennyvand Schmid (2002) used feeding boxes where food was placed in a box and could only be accessed if opened by the animal. Using feeding boxes showed lesser signs of stereotypy and pacing. Novel toys/objects are used in the lack of live prey. Artificial prey in the form of plastic rabbit replicas and bird sounds, cardboard box animals, sacks hung from trees that move when attacked, ropes for tugging, barrels containing stones for sound, watermelon that roll away when chased and frozen blood balls are used to encourage stalking, approaching and biting.

1.6.3 Olfactory enrichment

Many felid species communicate with other animals through spraying and scent marking. In the wild, they spend time patrolling and marking their territories. Addition of scents such as spices, feces from preys and woodchips/substrates from other enclosures can encourage their natural communicatory and territorial behaviours and increase stimulation. Tigers exhibited the highest increase in active behaviours and a decrease in pacing with implementation of spices.

1.7 Positive animal welfare

According to Rault et al. (2025) the definition of positive animal welfare is “the animal flourishing through the experience of predominantly positive mental states and the development of competence and resilience.”

Positive animal welfare is much more than ensuring good physical health and prevention and alleviation of suffering. It is a result of rewarding experiences, having choices and opportunity to actively pursue goals and achieve desired outcomes. Observation of behaviour, qualitative behaviour assessment using descriptors, physiological measures, longitudinal assessment are positive welfare assessment methods.

To promote positive welfare in captive felids, we can use the five domains model as a point of reference. Providing a balanced, species-appropriate diet with continuous access to free water and usage of novel feeding methods can be related to nutrition aspect of the animal. For the environment, applications of complexities in enclosures for hiding, climbing, etc. Sensory enrichments like scents can also be implemented. Health of the animal is a key aspect and can be monitored through regular veterinary care, preventive treatments and interventions in case of illness or injury. Behavioural interactions facilitate opportunities for cats to express natural behaviours and providing choice and control to interact with the

environment and humans can also increase in agency. Lastly, recognize the overall mental state that arises from experiences of the first four domains. Regularly assess mental well-being through behavioural observations and adjust care to enhance positive experiences.

1.8 Staff training in cognitive enrichment

Staff training improves the success of cognitive enrichment for captive felids in many ways, It enhances knowledge and skills of the keepers and helps to understand the felid cognitive abilities and species-specific needs which enables to design and implement appropriate cognitive challenges that effectively engage the animals' mental abilities. Trained staff are better able to research, plan and tailor enrichment activities to individual animals, ensuring that the right level of difficulty and variety is provided. Keepers can maintain regular enrichment schedules to observe animal responses accurately and implement changes if necessary to increase reliability and effectiveness in cognitive enrichments. Habituation of the animals to keepers helps to streamline the process making it more time efficient and less energy consuming for the keeper.

2. Aim

The aim of this study is to assess the welfare implications of structured training participation in three captive felids. It evaluates the engagement in different training activities to serve as a non-invasive behavioural indicator of welfare . The study explores whether increased willingness to participate in training has a correlation with improved state of psychological well-being. Ultimately, the study seeks to support the integration of training programs into routine animal care to promote behavioural welfare and agency in captive felids.

3. Materials and methods

3.1 Study site

This particular study was carried out in the Attica zoological park, Spata, Greece. All individuals had enclosures designed for protected contact under the relevant EAZA Husbandry guidelines with free access to indoor and outdoor areas of their enclosures. All enclosures had a mixed naturalistic and modified realistic habitat, relevant to each species' wild habitat. All enclosures had modifications in their outdoor areas to allow training with protected contact, via mesh walls and all training areas were near visitor viewing areas, except for the training area for the tiger. The chosen location of the training and observations ensured that any stressors were avoided.

Three different felid species participated. A single five-year-old male Sumatran tiger *(Pantera tigris sumatrae),* born in Attica Zoo. A seven-year-old female fishing cat (*Prionailurus viverrinus),* who was in Attica for five years and a four-year-old puma who was at the zoo for three years by the time this data was collected.

The individuals were at varying stages of training. Both the tiger and puma were target trained with the tiger having some previous training on this behaviour whereas the puma was being target trained for the first time. The fishing cat was being trained to keeper habituation but had prior training experience.

3.2 Initial study

The data was carried out over the month of august. An initial pilot study was observed prior to the data collection to eliminate the possibility of outliers due to human error.

The behaviours were observed on a five-day weekly basis for four weeks. To collect the behaviours, instantaneous sampling was used at one-minute intervals for an hour at different times per day.

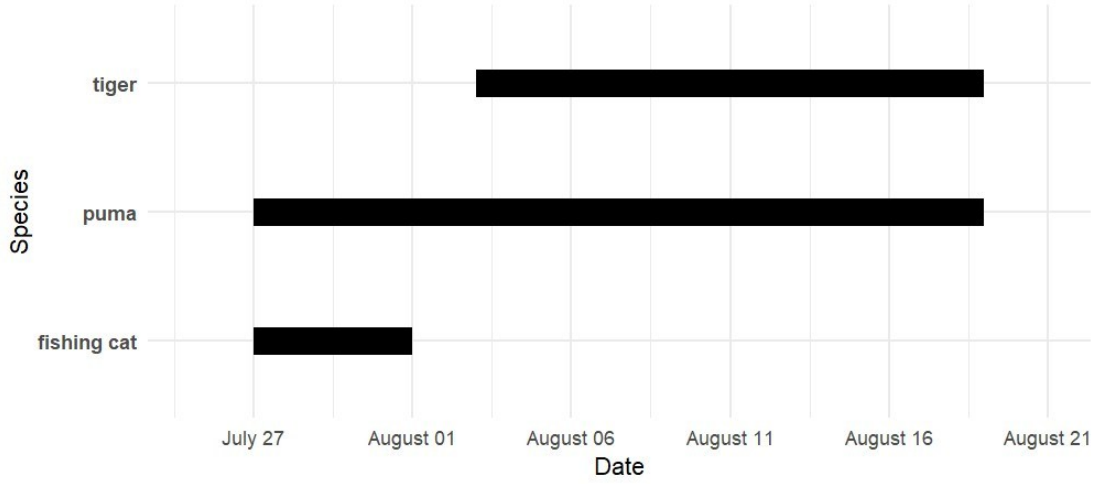

Figure 3: Training timeline

3.3 Training scoring

Each individual was scored on their

- Willingness to participate in the training from 1-4
- Approach to the training area from 1-3
- Their focus during the training from 1-3

Per day two species were trained and observed by a keeper and one researcher. Once the training session was completed, they were immediately scored by both raters and then observed.


Figure 1 (left): Puma (*Puma concolor*) resting in its enclosure during observational data collection

Figure 2 (right): Sumatran tiger (*Panthera tigris sumatrae*) sitting in its enclosure during behavioural monitoring

Behaviour	Code	Behaviour description	Negative/netral/positive welfare
Locomotion: walking	W	Moving around the enclosure with a slow steady pace	Neutral
Locomotion: running	R	Moving around the enclosure with a fast pace	Neutral
Resting	RE	Laying on the ground with open eyes	Neutral
Sleeping	S	Laying on the ground with closed eyes	Neutral
Eating	E	Consuming any food item	Neutral
Self-grooming	SG	Licking or scratching own body	Positive (Biolatti et al., 2016)
Using climbing apparatus	CA	Climbing or manipulating any elevated object	Positive (Ahlrot, 2016)
Agonistic behaviours	AB	Individual vocalises, scratches, lunges towards visitor barrier	Negative (Miller et al., 2020)
Stereotypic behaviours	SB	Abnormal repetitive behaviours with no obvious purpose	Negative (Mellor, 2014)
Other behaviours	O	Any behaviour that is not mentioned above	N/A
Not in view	N	Unable to see displayed behaviour	N/A

Table 1: Ethogram for behavioural observation of the study

Willingness to Participate: How willing to participate in the training did the individual seem throughout the whole training session**.**	**Approach:** Before the start of the training how did the individual approach the trainer.	**Focus:** How active was the individual during the training session.
1: Did not participate at all.	1: Did not approach the trainer.	1: No focus/did not participate.
2: Some interest but then left and did not return.	2: Started approaching but then got distracted.	2: Some focus but lost interest at some point during the session.
3: Interested in the training but left frequently and then came back.	3: Approached quickly and did not get distracted.	3: Great focus and interacted throughout the whole session.
4: Interested and stayed throughout the whole training session.		

Table 2: description and scoring scale for each training factor

3.4 Considerations for Reducing Fear and Anxiety Prior to Training

Desensitization in which gradual exposure to fear-inducing stimuli at levels that do not provoke a stress response are introduced to the animal. By exposing the animal to the stimuli systematically, it allows the animal to get accustomed to the presence or sound of stimulus without reacting negatively and enables the animal to remain more relaxed during potentially stressful situations.

Counterconditioning involves pairing a feared stimulus with a positive experience such as food, treats, praise or play. The aim is to change the emotional response of the animal from negative to positive which leads to increasing the willingness to participate in training routines.

Positive reinforcement training rewards desired behaviours to encourage repetition which build trust between the animal and handlers. It promotes voluntary participation and cooperation with the trainer unlike in punishment-based techniques.

Behavioural threshold management focuses on keeping animals below threshold by exposing them to triggers at a distance or intensity when they are calm. This prevents escalation of fear responses and allows gradual adaptations. Over time the animal can build tolerances and adapts gradually helping in gaining better learning outcomes.

Enrichment based confidence building uses cognitive enrichment activities to boost confidence and reduce fear. This promotes mental stimulation and reduces stress related behaviours while also contributing to an overall improved welfare and cooperation

3.5 Keeper habituation training methods

Habituation training reduces the fear-based responses by allowing animals to form predictable, positive association with keepers through the use of food, rewards, calm body language, and consistent routines. From a welfare perspective, an animal's willingness to voluntarily approach and interact with keepers may serve as an indicator of reduced fear and improved psychological well-being. Animals learn to associate the presence and actions of keepers with positive outcomes such as treats, praise or toys. This predictable and pleasant experience fosters confidence and reduces fear, making animals more likely to approach and interact with keepers. This autonomy is crucial for welfare and builds trust as animals feel safe and not forced into interactions.

Subject: Fishing cat (*Prionailurus viverrinus*)

The fishing cat had no previous exposure to formal training and displayed moderate avoidance behaviours toward keepers at the beginning

Training was conducted in the animal's enclosure where it was familiar to the space and surroundings and environmental stress. It had free access to hiding areas and all parts of the enclosure to ensure that the animal could withdraw if overwhelmed.

Procedure:

Initial exposure phase

Keeper remained at fixed point within the enclosure's visual field and did not interact directly with the animal.

Approach and reinforcement phase

Once the fishing cat showed tolerance, the keeper gradually decreased the distance towards the animal. A high value food reward was offered for maintaining close proximity or when the animal showed investigative behaviours like orientation or sniffing. **Interactive engagement phase**

Once comfortable with the keeper's proximity, the animal was encouraged to approach within a pre-set target distance. Cues such as vocal signals or presentation of food were used to invite interaction with the keeper. All of these behaviours were recorded using an ethogram.

All the collected data was converted into quantitative values scored by both the keeper and researcher and analyzed statistically using R Studio to understand the overall participation score.

3.6 Target training methods

Target training is a component of positive reinforcement-based training programs in zoological settings and has been widely implemented in the management of captive felids. This training method teaches the animal to orient towards, to follow or touch a designated object (in our case, a target stick) in exchange for a reward. This helps in acclimating animals to the presence, movement and interactions of their caregivers through repeated, structured exposure.

In felids, the training serves as a gateway to more complex husbandry behaviours, including voluntary shifting between enclosures, stationing for medical procedures and crate training for transport or health

checks. Since it includes voluntary participation, willingness to engage in target training can reflect an individual's motivation, confidence and overall emotional state. The latency, frequency and accuracy of the target responses can be quantified and used as an indirect welfare indicator.

All sessions were conducted in familiar enclosures to reduce stress. A protected contact system was used, while keeper was working outside a metal barrier for safety.

Habituation

Over the first few days, the animals were introduced to the target stick.

Shaping behaviour

Initially, reinforcement was given for orienting towards the target. Subsequent steps reinforced moving closer and then touching the target with the nose. When the animal began to touch the target consistently, the behaviour was put on cue using a verbal command.

Throughout training, positive reinforcement was used extensively (small pieces of red meat)

Behaviour monitoring

Detailed records were maintained each session including the time spent doing a specific activity, level of focus, willingness to participate, etc. No punishment or forced restraint was used. Participation was entirely voluntary and animals could disengage at any time.

3.7 Methods of increasing cognitive welfare of captive felids in zoos

Cognitive enrichment techniques include puzzle feeders and surprise boxes containing small pieces of meat which encourages the felids to engage in problem-solving to access food. This leads to increased activity and natural behaviours while reducing inactivity and stereotypical pacing. Novelty objects and sensory stimuli such as bones, frozen fish, spices like cinnamon and chili powder in enclosures stimulates exploration, rubbing, rolling and searching behaviours. Enhancing enclosure complexity with varied structures and stimuli allows felids to explore, investigate and manipulate their environment, promoting cognitive engagement and reducing boredom. Problem solving tasks provides opportunities for felids to control the aspects of their environment. This can include tasks that require discrimination, manipulation or decision making which have been linked to reducing abnormal behaviours.

3.8 Effect of interactions on training

Training programs are increasingly used in zoos to enhance social interactions among animals and between animals and humans. These programs aim to improve animal welfare by encouraging positive social behaviours, reducing aggression and fostering affiliative behaviours. Training can also benefit group dynamics and reduce stress.

From a practical perspective, training is a tool that helps zoo staff manage animal social behaviour more effectively. By using methods like positive reinforcements, they can encourage animals to engage in friendly behaviours and reduce conflict and stress in group settings.

From a psychological and ethological viewpoint, training leverages principles and learning theory to shape desirable behaviours. This can increase prosocial behaviours like grooming or playing while minimizing aggression which supports the mental and physical health of captive animals

3.9 Modern animal training methods

Modern animal training procedures are linked to two major events: (i) Skinner's discovery (2025) of shaping, or the differential reinforcement of successive approximations to a target response where Skinner discovered how complex behaviours can be taught by reinforcing small, incremental steps called successive approximations by relying on positive reinforcement rather than punishment; and (ii) the creation of a field of Applied Animal Psychology by Keller and Marian Breland (1951) and based on Skinner's operant conditioning principles. Keller and Breland used their lab-based discoveries to train animals for shows, advertisements and education by emphasizing on motivation, reward and understanding animal cognition. Modern animal training procedures have had the benefit of giving animals the choice to actively participate in interactions that result in improved veterinary care. However, using training to improve husbandry practices, and therefore the physiological welfare of an animal, is fundamentally different than saying that training itself is enriching.

If we divide the outcome of the literature review into three specific categories: (i) training facilitates enrichment usage; (ii) training modifies interactions, conspecific or otherwise; and (iii) training expands behavioural repertoires, we can understand how training functions as enrichment.

3.9.1 Training facilitates enrichment usage.

Some studies show us a strong relation between training and enrichment usage. Markowitz and LaForse (1987) were able to increase the overall activity including increased foraging/hunting behaviours and reduced time spent idle by training and rewarding two African servals (*Leptailurus serval*) for chasing artificial prey through a constructed tube in the exhibit. Markowitz et al. (1995) trained and rewarded a African leopard (*Panthera pardus pardus*) for stalking and chasing naturalistic acoustic prey such as bird songs along an artificial tree trunk.

Fernandez et al. (2019) were able to use an auto-shaping procedure to combine training and enrichment to increase the time spent swimming and interacting with the devices post-training. Enrichment usage is a direct method of demonstrating that training can be enriching.

3.9.2 Training modifies interactions, conspecifics or otherwise.

Experimental studies on animal settings are very limited. Bloomsmith et al (1994) were able to effectively use a positive reinforcement training procedure to reduce aggression during feeding times in group-housed chimpanzees. Schapiro et al. (2001) showed positive reinforcement training increased the affiliative behaviours outside of training sessions for otherwise less social rhesus macaques (*Macaca mulatta*). Pomerantz and Terkel (2009) used positive reinforcement to increase chimpanzee prosocial

behaviours like grooming and playing outside of training sessions. These studies are a few examples to provide support for the concept that training can function as enrichment by modifying the interactions between their conspecifics.

Human animal interactions (HAIs) are a growing area of research especially in zoo settings with mixed outcomes. Positive HAIs can serve as enrichment and improve welfare, especially when animals seek out interactions. Negative or forced HAIs may increase stress or aggression. HAIs vary on the species, individual animal history and nature of human involvement. Positive examples are voluntary engagement with keepers while negative examples include stress during public feeding shows.

3.9.3 Training expands behavioural repertoires

This idea that training produces new behaviours that result in enriched welfare for those animals is the most difficult out of the three to demonstrate. However, some examples like Hare and Sevenich (2001) showed an increase in scratching of tree by tiger using enrichment and training. Multiple scents were placed on the deadfall tree in the tiger's exhibit and the tiger was rewarded for tree scratching. Greater testing is necessary, particularly with respect to the direct comparison of training and traditional environmental enrichment conditions.

3.10 Animal agency assessment

Animal agency according to Emilie Edelblutte (2023) is defined as the ability of animals to actively influence conservation and management outcomes through their adaptive, context-specific, and complex behaviours. Agency is rooted in their sentience, individuality, life experiences, cognition, sociality, and cultures, allowing animals to shape and reshape shared human-wildlife cultures and histories.

According to Edelblutte, rather than treating wildlife as passive objects to be managed, we need to recognize animal agency and its meaning while considering animals as partners in their own conservation. Their behaviours, personalities, group decisions, relationships with humans should inform and improve conservation practices.

With respect to big cats, agency can refer to their capacity to make choices and adapt to their environments while influencing their own welfare and management outcomes through their unique personalities, behaviours and social interactions. Since each individual has a distinct personality, it affects how the animal responds to different stressors and interacts with different environments. Coping styles are crucial for our understanding of the animal because they play a vital role in the adaptation to captivity, enrichment and social settings. When a big cat actively engages with their environment, seeks enrichment and expresses preferences as a response to the environment, it shows their role as an active participant in their own care and management. One of the other ways of display of animal agency in big cats is their influence on welfare and management when they are provided with choices and opportunities to express natural behaviours like different designs of enclosures and husbandry practices which can improve their welfare.

3.11 Application of the five freedoms and five domains

To assess the welfare implications of training in captive felids, the study applies both the Five Freedoms and Five Domains frameworks. Both models offer a complementary perspective where the Five Freedoms focus more on the minimum standards for the animal and its welfare while the Five Domains provide a more advanced, nuanced tool for assessing both negative and positive welfare states.

Freedom from hunger and thirst which is related to the domain of nutrition, incorporates the use of food for reward which ensures regular access to nutrition and also stimulates the feeding behaviours. Using high value reward not only met dietary needs but also promoted positive anticipation, active engagement in feeding behaviour.

Freedom from discomfort was related to the physical environmental domain. The trainings for all three animals were conducted in a familiar enclosure and through protected contact systems. Animals had access to choice and space allowing retreat or disengagement.

Freedom from pain, injury or disease related to domain of health was implemented by allowing voluntary participation without the use of restraint or aversive methods. This helped in promoting cooperative medical behaviours and in reducing the need for sedation or force handling in the future.

Freedom to express normal behaviour related to the behavioural interactions' domain was implemented by encouraging natural behaviours such as approach, investigation and interaction with keeper or other stimuli. The sessions for training provided mental stimulation, reduced stereotypy, supported cognitive engagement and overall motivated the animal to display species-specific behaviours.

Freedom from fear and distress from the mental state domain aimed to reduce fear-based responses through desensitization and counterconditioning. The aim was to increase the confidence and trust between the animal and keeper. Training gave them agency and control over their environment and contributes to an overall better mental state.

4. Results and discussion

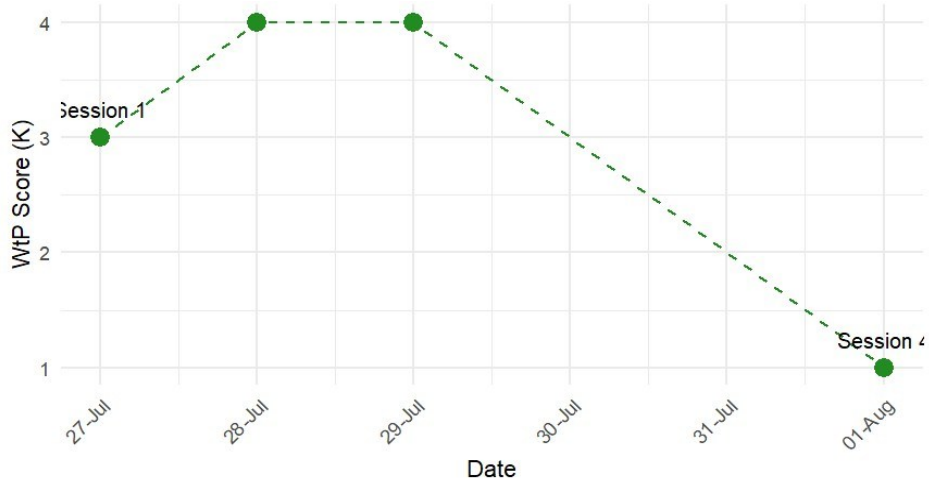

Figure 4: Graphical representation of the scores of the willingness to participate (WtP) of fishing cat

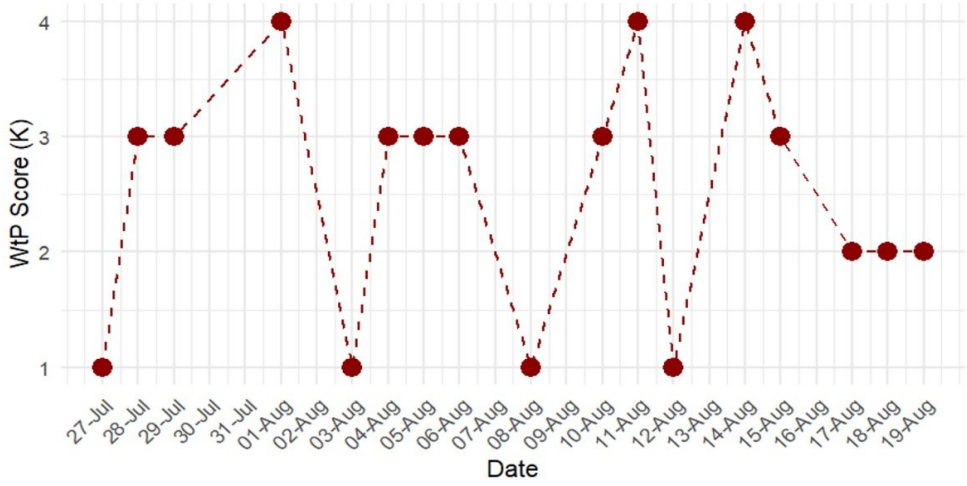

Figure 5: Graphical representation of the scores of the willingness to participate of puma

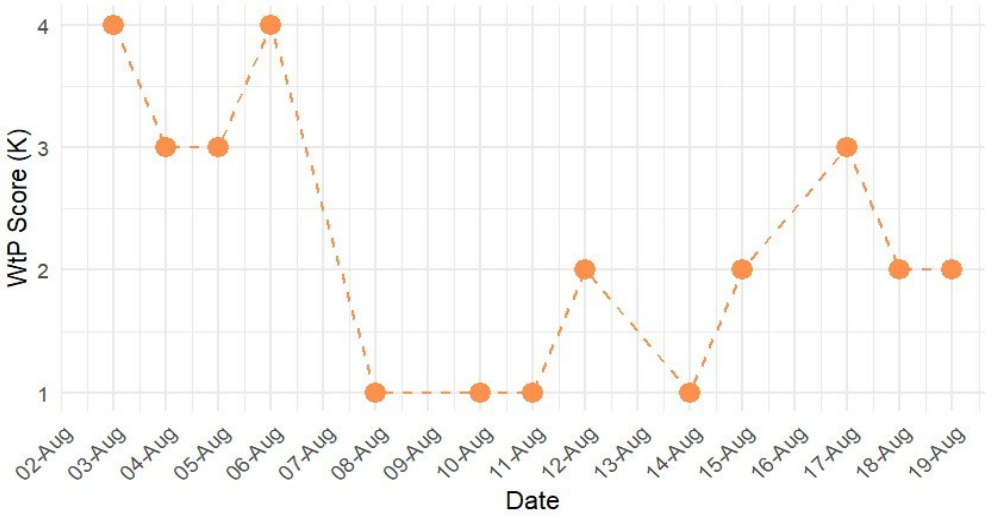

Figure 6: Graphical representation of the scores of the willingness to participate of tiger

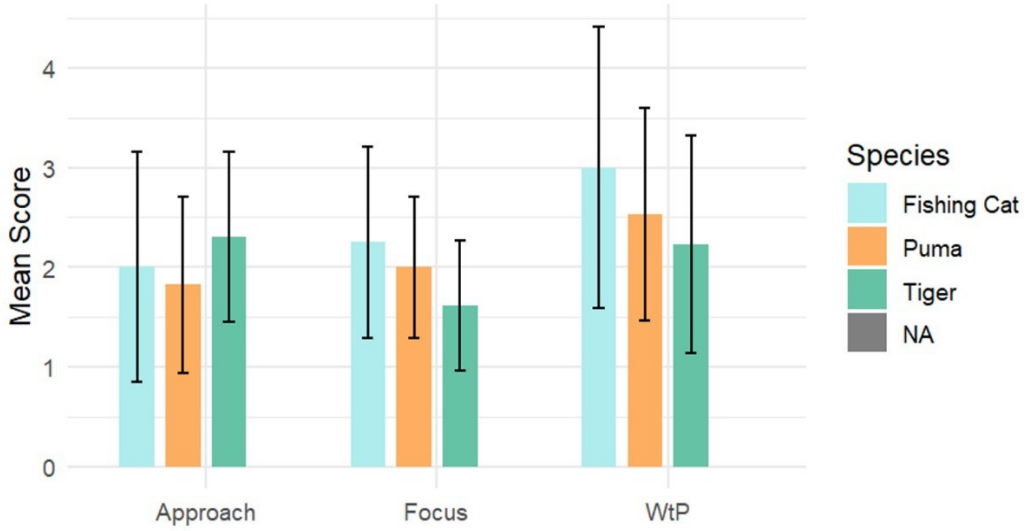

Figure 7: Graphical representation of mean Approach, Focus and Willingness to participate

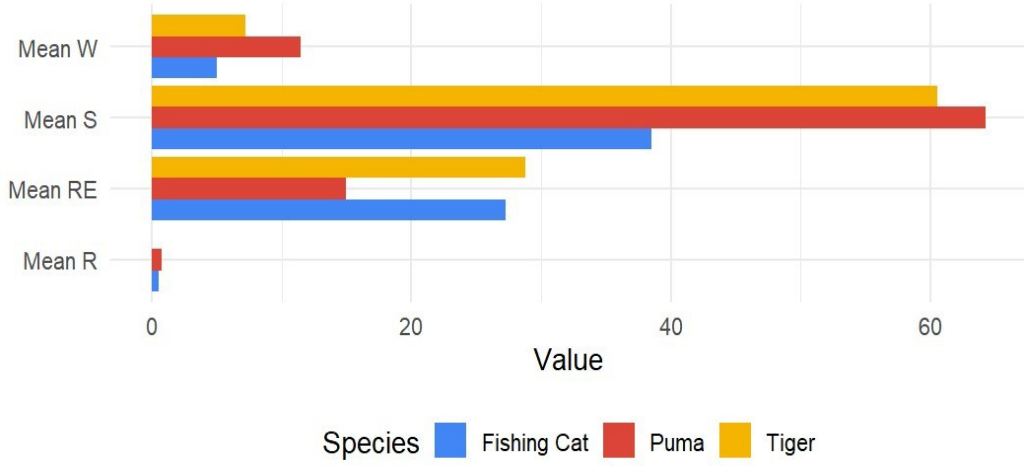

Figure 8: Horizontal bar graph showing mean values for Walking, Sleeping, Resting and Running for each animal

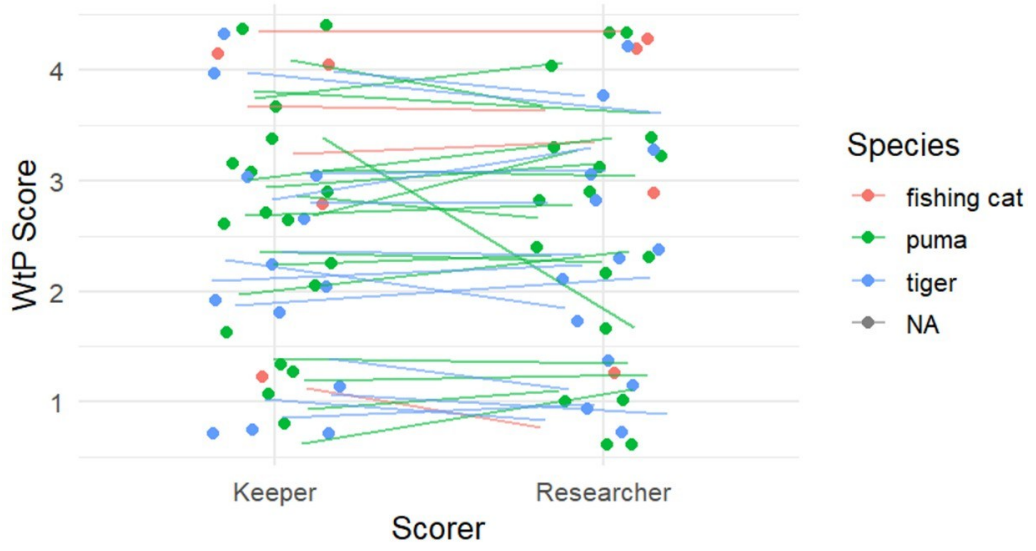

Figure 9: Scatter plot showing comparison of scores between keeper and researcher

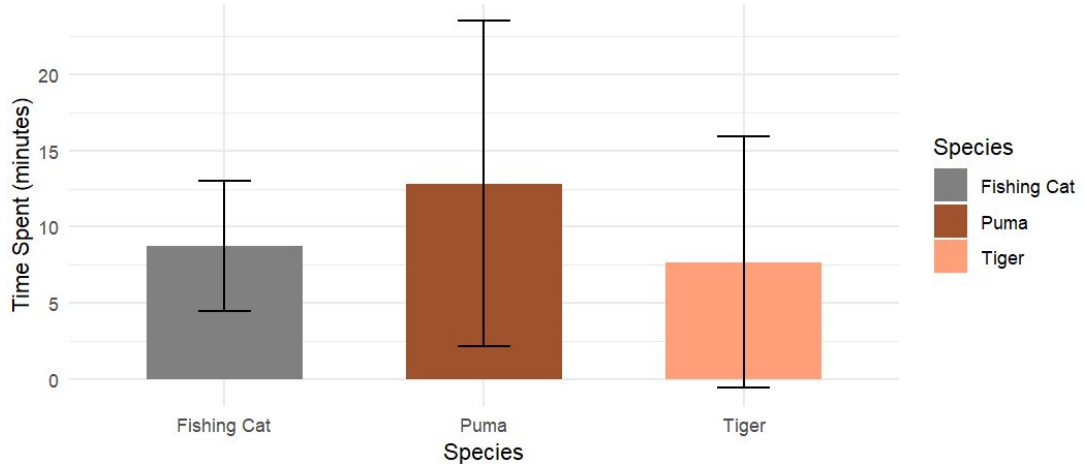

Figure 10: Graphical representation of total time spent on locomotion: Walking, Running, Climbing

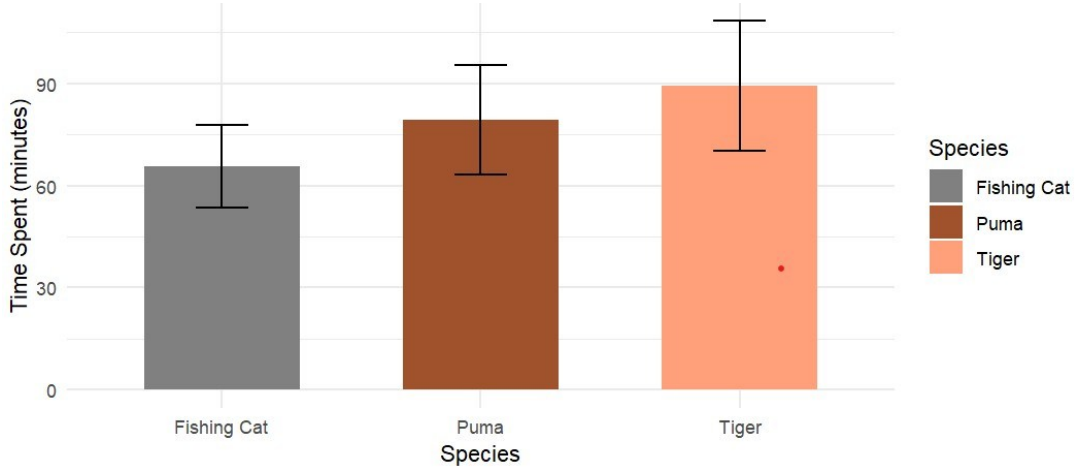

Figure 11: Graphical representation of total time spent passively: Resting, Sleeping

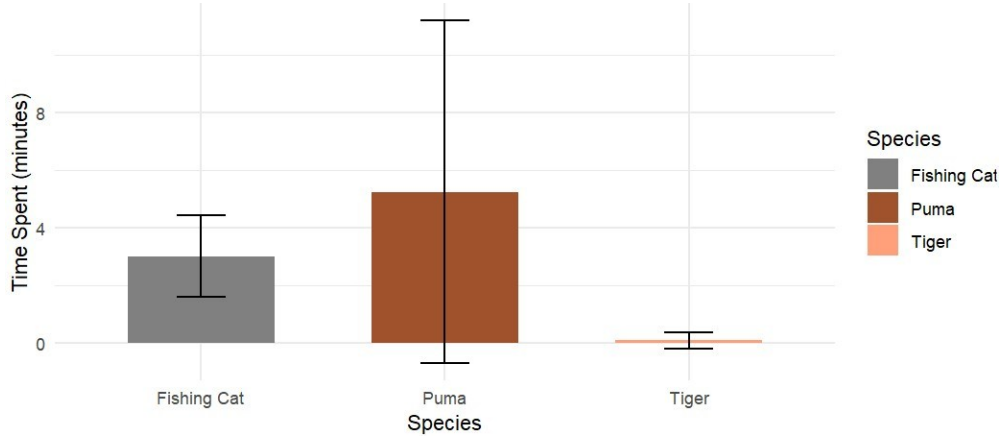

Figure 12: Graphical representation of total time spent eating

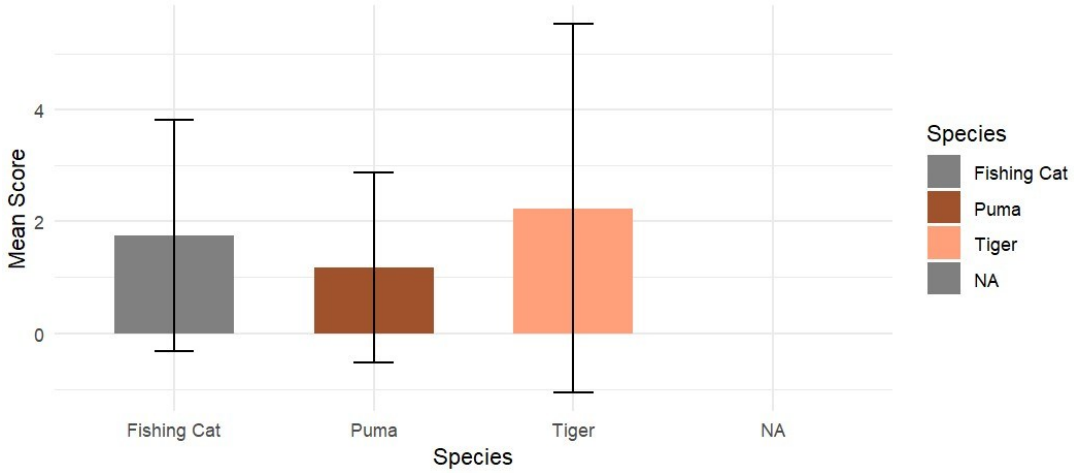

Figure 13: Graphical representation of total time spent displaying negative welfare indicators: Stereotypical behaviours and agonistic behaviours

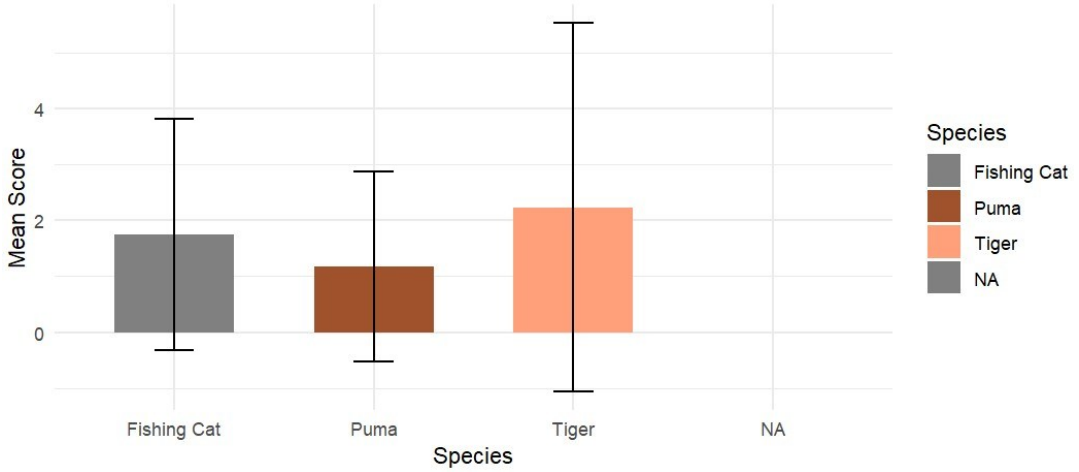

Figure 14: Graphical representation of time spent doing other activities or not in view

4.1 Willingness to participate analysis

To evaluate the effectiveness of training programs and their impact on welfare, Figure 4, Figure 5 and Figure 6 are able to provide us with a clear depiction of the trends across the training periods. The fishing cat's training timeline (Figure 4) shows an initial high WtP score for the first three session with a maintenance score of 3-4 which is followed by a sudden decline to score 1 during the last session. This suggests the fishing cat's initial curiosity or motivation rapidly decreased. The puma (Figure 5) shows a fluctuating pattern in WtP scores throughout its training period. Scores frequently peaked at 4 and dropped to 1 intermittently. Although it maintains high engagement levels, the puma also exhibits sudden decreases which could suggest some differences due to its preferences and external factors during training sessions. The tiger (Figure 6) shows a noticeable decline in WtP scores over the monitored period. It displayed strong engagement and motivation towards training at the outset but was followed by the scores dropping as low as 1 towards the end with only a slight recovery later on. This could be due to the decrease in motivation,

possible boredom from repeated training stimuli or decrease in novelty. The bar graphs are depicting the mean WtP scores by species revealing that the fishing cat achieved the highest mean scores followed by the tiger and puma with lower averages. Unlike the tiger, the puma showed a more stable trend without sudden drops or rise in willingness to participate. The fishing cat even with fewest sessions had the sharpest decline among the three animals because it showed a sudden loss in interest unlike the tiger which was participating less over time. The bar graph depicting the mean WtP scores by species reveals that the fishing cat achieved the highest mean scores followed by the tiger and puma with lower averages. This finding correlates with the session counts and reflects the greater training effort directed towards tigers and pumas. However, the lower engagement in fishing cats despite fewer sessions highlights the importance of considering not just total training time but the quality and responsiveness during those sessions.

4.2 Evaluation of average scores of species

Figure 7 compares the average scores with standard deviations for Approach, Focus and WtP for all three species. This helps us to understand the engagement patterns during the training period. Fishing cat display the highest average scores across all three metrics with high approach and focus scores. A strong readiness to engage with trainers and remain attentive during training sessions and general receptiveness to training is observed. Tigers and pumas show lower average scores across these measures with the tiger displaying a slightly higher approach score than the puma but comparable focus scores. The large standard deviations in puma indicates greater variability in its responsiveness during training aligning with the WtP scores. Participation of the tiger across approach and focus is consistent. Overall we can observe the differences in behavioural participation during training.

4.3 Mean activity scores evaluation across species

Figure 8 compares the mean proportions of key active states i.e. walking(W), sleeping(S), resting (RE), and running(R). These activities offer indirect measurement of welfare, energy expenditure and behavioural expression. Fishing cat displays a high mean value for walking and running indicating a high level of active engagement and locomotion in their enclosures. Their low profile for sleeping and resting reinforces their active behaviours and can be interpreted as an indicator of good welfare. In contrast, pumas and tigers show high mean values for sleeping and resting. This suggests a more sedentary pattern but aligns with the species-specific resting needs. This graph is essential to understand the species-specific activity budgets and important for understanding the outcomes.

4.4 Paired comparison of WtP scores between keeper and researcher

Figure 9 is a scatter plot with connecting lines to compare the WtP scores assessed by the keeper and the researcher for all individual animals. This includes an idea of inter-rater consistency and potential observer bias across species. The pattern indicates a general consistency with many points lying close to diagonal suggesting alignment in scoring the observing groups. The red cluster for fishing cat reflects

consistent observations of high willingness to participate. Green and blue for the puma and tiger show a wider spread of scores showing variability. This is a reflection of subjective differences in perception of participation. In conclusion, overall trends in species-specific engagement remains robust across scorers despite few minor differences.

4.5 Locomotion and active participation assessment

From Figure 10 we are able to understand the combined amount of time spent for locomoting which includes walking(W), running(R) and using climbing apparatus (CA). The puma shows the highest average time with a large error margin. Tiger shows the least time and variation which helps us understand that the puma engages most in moving around its enclosure.

4.6 Resting and sleeping assessment

To understand how much time an animal spent passive by resting (RE) and sleeping(S), Figure 11 can be considered. From the graph we can conclude that the tiger spends most time laying down or sleeping with the puma also following the tiger by a small margin. Out of all, the fishing cat shows the least time resting or sleeping in one place.

4.7 Feeding assessment

From Figure 12 we can interpret the time spent eating by the animals. The tiger shows a very low score indicating that it did not show any feeding behaviours during the training period. The fishing cat falls in between the tiger and puma with a moderate feeding behaviour. Of all, the puma spends the most time eating.

4.8 Negative behaviours assessment

From Figure 13 we can notice how the tiger displays agonistic (AB) and stereotypical behaviours (SB) the most. Error bars in the standard deviation suggests that the tiger shows a wide variability in these behaviours. The puma and fishing cat both show low and relatively similar scores.

4.9 Supplementary behavioural data assessment

Figure 14 is a depiction of the time when the animal displayed other behaviours or was in hiding and not in direct view with the keeper and researcher. Fishing cat has the biggest bar showing that it spent the most time either in hiding or performing other activities. Meanwhile, the puma and tiger show considerably lower means with low variability unlike the fishing cat which displays a high variability.

Overall, the tiger displayed the highest stereotypy and resting patterns. The fishing cat showed highest activity patterns by maintaining the least time resting and more time exploring the enclosure. The puma

showed the most behavioural variability indicating flexibility in activity patterns. Most of the behaviours represented go hand-in-hand with the species-specific behaviours of all these animals.

The outcomes from this study have highlighted the behavioural variation observed within the three subjects. It emphasizes on participation and species-specific behaviour but also in understanding individual temperament and experience. Receiving a unique pattern of engagement indicated that cognitive enrichment efforts must be adapted to individual needs. Well trained staff and their interpretation of the results to check for the scores supported the use of observational tools in day-to-day welfare monitoring. Ethogram based analysis reinforced the idea of training and its influence on aspects regarding the welfare beyond the training sessions as well. The results point to the interconnectedness of cognitive stimulation, behavioural expression and emotional well-being in captive felids and underline the importance of training not for isolation but as a growing aspect in wider welfare framework.

4.10 Future prospects

Willingness to participate should be used in captive settings to focus on refining and formalizing the use of willingness to participate as a behavioural welfare indicator. This must include creating species-specific standards, validating WtP scores against physiological and hormonal stress indicators while being integrated with other existing welfare frameworks such as the Five freedoms and Five domains model. By doing so, zoos and wildlife facilities could adopt more predictive and preventative welfare strategies.

With the development of technology, we should be able to implement automated behavioural tracking or app-based scoring system to improve the data consistency and allow large scale and multi-international studies. Embedding WtP scores into routine protocols not only enhances the welfare assessment but also supports an ethical response in animal management where behavioural choice and agency are centers to practice. Embracing this approach could transform the welfare assessment from a reactive process into a proactive and animal-led model by prioritizing individual needs and voluntary engagement.

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