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# Environmental Enrichment : How to provide natural behaviours and good animal welfare in captivity

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## Introduction

Throughout history domesticated animals, livestock but also wild animals have been kept in captivity under human care in private homes, farms, laboratories, zoos and aquariums. Divine creatures in ancient Egypt, sacred menageries in ancient Greece, elephants of Alexander the Great, and spectacles in the Colosseum in ancient Rome, animals have been kept in captivity for thousands of years, as a symbol of power, wealth, and had some religious significance.

The model of the modern zoo became popular in the 18th century, during the Age of Enlightenment, when the scientific focus was extended to zoology. Scientists started to research animal behaviour and anatomy, in enclosures that resembled animals' natural habitats. Due to culture, history, economy and politics, drastic changes have occurred in the ways animals are considered and treated. Zoos were originally made to display animals, and entertain the public. Today, they are meant to educate people, raising awareness and serve scientific research, and with species threatened and habitats disappearing worldwide, zoos are playing a new role in conservation. Many captive breeding programs use animals as "gene banks" with the goal of breeding and re-introducting endangered or extinct species into the wild. These programs can be very useful in many situations, after natural disasters like devastating fires, or diseases like the transmissible cancer in Tasmanian devils called facial tumour disease for example. The animals in our zoos now fulfil several roles, from education to ambassadors for their species.

Today, around 1 million vertebrate animals live in captivity worldwide. There are over 10,000 zoos across the globe, with only 240 accredited by the Association of zoos and aquariums (AZA), counting more than 600 million visitors annually. AZA accredited establishments requires high standards of animal management and care, including living environments, enrichment, social groupings, health, and nutrition. The Accreditation Commission also evaluates the veterinary program, involvement in conservation and research, education programs, safety policies and procedures, security, physical facilities, guest services, and the quality of the institution's staff. These statistics and standards only account for the official and accredited zoos, while roadside attractions and private zoos are not included in them. But in what conditions do animals live in the thousands of other zoos?

The universal declaration of animals' rights was proclaimed on the 15th of October 1978 at the UNESCO headquarters. Moreover the EU has some of the world's highest animal welfare standards. The general rules regarding keeping of animals says that living conditions

for the animal should be in accordance with the physical, physiological, husbandry and ethological characteristics of its species, breed, sex and age and its state of health and meet its husbandry and nutritional needs (housing, feeding, treatment, cleanliness, rest, care, training, education, supervision). But what about the rest of the world? This map (Figure 1) is an interactive tool from World Animal Protection, who ranked 50 countries worldwide on how well their legislation protects animals to give a review on animal welfare standards.

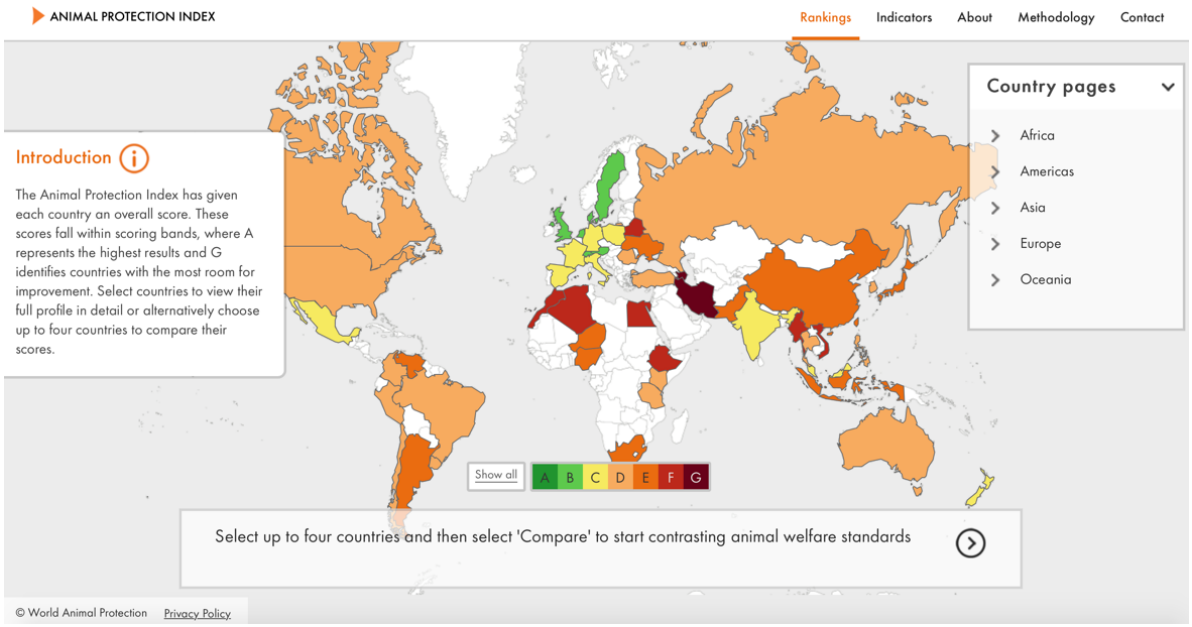


*Figure 1 - Animal Protection Index by World Animal Protection*

In some countries more than others, animals are living in terrible conditions and legislations aren't protecting them. But how can we keep improving animal welfare around the world?

Scientifically addressing questions regarding animal welfare is timely and relevant because of the broad public interest in the care and management of animals in captivity, zoos and aquariums. This is true for all species, as they pose management challenges due to their many profiles, especially the high-profile ones, which are intelligent, highly social, and inhabit large home ranges in the wild. The years trying the understand animals and the many researches have demonstrated that animals are sentient beings with emotions and needs.

In order to offer good welfare for purposes such as conservation, it is important to reach optimal enrichment programs fulfilling animals' needs. Zoological professionals and visitors require objective information about how housing and management practices in zoos can influence animal welfare through behaviour, physiology, and emotions both positively and negatively.

This paper begins with an introduction to the field of animal welfare science, notably through its relationship to the notion of natural and stereotypic behaviours, before giving you an overview of the many beneficial enrichments available and a review of the numerous studies completed. Later, it will demonstrate why and how enrichment should be implemented for the welfare and security of animals in captivity. And finally, an example of enrichment program for lions will be proposed.

## Literature review

## 1. Animal welfare

### 1.1 What is animal welfare and how can we assess it ?

**Animal welfare** is a complex and multi-faceted subject with scientific, ethical, economic, cultural, social, religious and political dimensions. According to the OIE Terrestrial Code, animal welfare means "the physical and mental state of an animal in relation to the conditions in which it lives and dies".

Developed by the Farm Animal Welfare Council, the **Five Freedoms** have been the basis of animal welfare and affirm every living being has right to humane treatment. Internationally adopted by representative groups including the **World Organization for Animal Health (OIE)** and the **Royal Society for the Prevention of Cruelty to Animals (RSPCA)**, they are the standards of care and used as the basis in writing animal care protocols and laws. They describe society's expectations for the conditions animals should experience when under human control, namely:

- Freedom from hunger, and thirst;
- Freedom from fear and distress;
- Freedom from discomfort;
- Freedom from pain, injury and disease;
- Freedom to express normal behaviour

According to **Welfare Quality® protocols,** animal welfare assessments must take four questions into account:

- Are the animals properly fed?
- Are the animals properly housed?
- Are the animals healthy?
- Does the behaviour of the animals reflect optimised emotional states?

Those questions give rise to a set of **12 principles and criteria** forming the welfare quality® protocols:

- Good feeding
    - Absence of prolonged hunger.
    - Absence of prolonged thirst.

- Good housing
    - Comfort around resting.
    - Thermal comfort.
    - Ease of movement.

- Good health
    - Absence of injuries.
    - Absence of disease.
    - Absence of pain induced by management procedures.

- Appropriate behaviour
    - Expression of appropriate social behaviour, such that there is a balance between negative aspects (e.g. Aggressiveness) and positive ones.
    - Appropriate expression of other behaviours, such that there is a proper balance between negative aspects (e.g. stereotyped behaviour) and positive ones.
    - Good human-animal relationships, such that the animals do not fear humans.
    - Positive emotional state.

Table 1 illustrates an example of 14 welfare criteria with the Orange-winged Amazon parrot (Amazona Amazonica) according to the welfare quality® protocols :

| Welfare Principles | Welfare Criteria | Example evidence reference |
|---|---|---|
| **Good feeding: Are the animals properly fed and supplied with water?** | 1. Absence of prolonged hunger (i.e. mimic natural feeding intervals). Other end of the spectrum should also be considered, i.e. prevention of obesity. | Over-sized pellets provide foraging-like opportunities reducing inactivity and encourages a more naturalistic activity budget (Rozek et al., 2010). These parrots usually feed early morning (30 min after sunrise when leave roost) and late afternoon so attempts should be made to mimic these intervals in captivity. |
| | 2. Access to appropriate food and species-typical foraging opportunities (i.e. they should have a nutritionally suitable and appropriate diet & delivery). | Information on breadth of diet and utilisation of palms for fruit foraging (Bonadie and Bacon, 2000).<br>Captive parrot nutrition: Interactions between anatomy, physiology, and behaviour (Matson and Koutsos, 2008).<br>Over-sized pellets elicit comparable podomandibulation (handling with beak and foot) behaviour (Rozek and Millam, 2011). |
| | 3. Absence of prolonged thirst (i.e. they should have a sufficient and accessible water supply). | Clean drinking water must be available at all times and refreshed at least daily (Kalmar et al., 2010). |
| **Good housing: Are the animals properly housed?** | 4. Animals should have comfort when they are resting and sleeping (i.e. physically comfortable and relaxed, not always vigilant). | On Trinidad palms function as roosting and nesting sites (Bonadie and Bacon, 2000). |
| | 5. Animals should have thermal comfort (i.e. they should neither be too hot nor too cold, and have thermal zones to choose from). | Temperature, humidity, and environmental housing parameters (Kalmar et al., 2010). |
| | 6. Animals should have enough space to be able to move around freely in relation to natural locomotion (e.g. leap distance, orientation of substrates etc.), and in context of indoor-outdoor space restrictions. | Habitat use in and around two lowland Atlantic forest reserves in Brazil (Marsden et al., 2000). |

| | | |
|---|---|---|
| | 7. Animals should have perceived control (i.e. complex enclosure giving them choice over what and when they do things). | Preferences for cage enrichment devices (Kim et al., 2009). |
| **Good health: Are the animals healthy?** | 8. Animals should be free of major injuries (e.g. skin damage and locomotory disorders). | Development of a reference for xeroradiographic and conventional radio-graphic anatomy and its importance to clinical evaluation (Smith et al., 1990). |
| | 9. Animals should be free from disease (i.e. appropriate standards of hygiene and care). | The basic cage care includes daily cleaning of the water and food dishes. Weekly wash of all the perches and dirty toys, and the floor should be washed about every other week. A total hosing down and disinfecting of an aviary should be done yearly, replacing anything that needs to be freshened, such as old dishes, toys and perches. |
| | 10.Animals should not suffer pain induced by inappropriate management, handling, catching, or transport. | Normal haematological parameters (Tell et al., 1997). Capture, restraint, sample collection, high-quality nutrition, and intellectual stimulation: An overview of avian care and husbandry (Schulte and Rupley, 2004). |
| | 11. Animals should be treated well in all situations (i.e. care staff should promote good human-animal relationships, with the animal's perspective as the focus). | Short neonatal handling of parent-reared birds increases tameness and improves adaptation to life in captivity (Aengus and Millam, 1999). |
| **Appropriate behaviour: Does the behaviour of the animals reflect optimized emotional states?** | 12. Animals should be able to express normal, non-harmful, social behaviours (e.g. preening, breeding). | Pair housing significantly improves environmental quality and positively affects animal welfare (Meehan et al., 2003). Captive animals show a preference for morning bathing compared to other times of the day (Murphy et al., 2011). Environmental enrichment and social manipulations (including misting, fruit supplementation, nest hole restriction, enlarged nest boxes, and pair separation/reunification) increases reproductive performances (Millam et al., 1995).<br>Social play behaviour of two juvenile white-fronted Amazon Parrots (Amazona albifrons) includes bill-nibbling, pseudo-copulation, play-solicitation, play- |

| | | |
|---|---|---|
| | | biting and fighting and foot-clawing, possibly to increase social ties between birds and develop adult behaviours used in epigamic and agonistic contexts (Skeate, 1985) |
| | 13.Animals should be able to express other normal behaviours (i.e. it should be possible to express species-specific natural behaviours such as exploring, problem solving). | Cognitive flexibility, memory, lateralization and individual differences (Cussen and Mench, 2014).<br>Colour, hardness, size and material all influence environmental device use (Kim et al., 2009).<br>Level of novelty experienced during early life affects neophobia development (Fox and Millam, 2004). |
| | 14. Negative emotions such as fear, distress, frustration or boredom/ apathy should be avoided whereas positive emotions such as security or contentment should be promoted. | Social play analysis in different species of parrots, e.g. play chases, play fighting, wild careering flights, physical interactions (rolling on the back and jumping on the belly) (Diamond and Bond, 2003). Novelty and individual differences influence neophobia (Fox and Millam, 2007).<br>Genetics, environmental aspects, and neighbours affect the severity of stereotypies and feather picking (Garner et al., 2006). |

*Table 1 - Welfare criteria based on the welfare quality® protocols for an Orange-winged Amazon parrot (Brando et al, 2018)*

Animal Welfare can be subjective and complex to identify and measure, but there are different parameters which can reflect it, (Veissier & Boissy 2009), such as :

- Pathology and Health – Body condition with muscle/fat ratio, weight loss, impact on growth, low life expectancy, poor coat appearance, body damage, presence of ulcers, disease and infection signs
- Productivity & Reproduction – absence of milk, absence of reproduction
- Physiology – increased heart rate and blood pressure, immunosuppression, increase adrenal activity with high cortisol levels indicating high level of stress, decrease noradrenaline,
- Neurology – Decrease in brain cell density, decrease in cerebral plasticity, memory
- **Behaviour – Stereotypies, aggression, self-mutilation, movements and posture**

Defining and measuring animal welfare is not straightforward (e.g. Mason and Mendl, 1993; reviewed in Fraser, 2009). Behavioural, physiological, psychological, and biochemical measures need to be integrated to provide a holistic view (Broom, 2007, 2014). "Animal welfare is defined as the **absence of suffering and the respect of animals' needs**, not only imperative and nutritional – which would mean good treatment – but also behavioural." (Sueur and Pelé 2019). The rate and amplitude of signs can indicate the intensity of the constraint or suffering. The value of combining physiological measurements with behavioural assessments is an effective way of furthering our understanding of behavioural motivation and causation. This has been demonstrated by a large number of studies, one held by Shepherdson et al., (2004) for example.

There are tree complementary approaches. The first one is the naturalist approach, which considers that an animal must be able to live its natural life (Rolin, 1993), by recreating the animal's natural environment. The second is the behavioural approach which is based on the principle that all individuals have mechanisms to adapt to their environment to achieve a state of homeostasis (behavioural stability) even if the captive environment is not visually similar to its wild environment. The third one is the mental approach and should result in a state without prolonged negative emotions like fear, pain, frustration, includes the notion of sentience (Sueur and Pelé 2019).

In this paper, we will focus on discussing the behavioural aspects of animal welfare as it is the most useful and straightforward indicator of poor welfare.

### 1.2 Natural behaviours and their diversity

There is no single standard for a natural behaviour or a natural environment and it is often unclear. Natural behaviour may be defined as behaviour that animals have a tendency to exhibit under natural conditions, because these behaviours are **pleasurable and promote biological functioning**. Animals have evolved cognitive-emotional systems ("welfare needs") and do not only have so-called physiological needs such as the need for food, water, and thermal comfort. They also need to exercise certain natural behaviours such as rooting or nest-building in pigs, and scratching or dust-bathing in poultry. All needs must be taken into account in order to assess overall welfare.

Animals have a very diverse natural behaviour repertoire which is **species-specific** but their motivation **depends on the weather, the individuals sex, lifestage, background, reproductive condition and personality.**

The most common natural behaviours are:

- Sleeping & resting
- Self-maintaining: feeding, foraging
- Exploratory
- Social: territoriality, reproduction, animal-animal interactions or human-animal interactions
- Reproductive: mate choice, courtship, mating, rearing offsprings
- Playing

Let's compare to two wide-ranging lifestyle species of felids (Felidae family) and discuss their natural behaviours in the wild.

***Example 1 - African lion's natural behaviour***

African lions (Panthera leo) live in community. They are unique as they are the only big cats to live in groups which we call prides. These family units usually are composed of up to three males, a dozen females, and their young. They are primarily nocturnal or crepuscular and spend most of their day resting, often up to 20 hours per day. In the wild, lions rest for energy conservation, because of lack of prey and to avoid the heat. Males defend the pride's territory composed of grasslands, scrub, or open woodlands, while the females are in charge of hunting. They usually work as a group and attack from different directions as they are slower than their prey. During the rest of the day, lions have many social interactions. They gather and sleep in groups, rubbing their heads against each other and play together. Female lions raise their young together and will feed cubs other than their own. New males to a pride may kill the new cubs to mate with females.

*Table 2 – Ethogram comprising lions natural behaviours:*

| | |
|---|---|
| **Inactive** | **RHEF**- resting head erect far from conspecific |
| | **RHEN**- resting head erect near conspecific |
| | **RHDF**- resting head down far from conspecific |
| | **RHDN**- resting head down near conspecific |
| | **Sit**- all four feet on ground, front legs straight, back legs folded |
| | **Yawn**- mouth opens wide then closes, no noise |

| | |
|---|---|
| **Activity : Locomotion, Feeding, Hunting, Territorial, Social** | **Stand**- all four feet on ground, legs straight |
| | **Crouch**- similar to sit but with front legs folded as well, head forward and erect, ears and eyes alert |
| | **Stretch**- stretches out muscles, usually after resting |
| | **Roll**- rolls from one side of body to the other, usually during resting |
| | **Walk**- moving one foot in front of the other while standing |
| | **Run**- very quick walk |
| | **Jump**- crouch then leap through air |
| | **Chase**- run after conspecific or other being |
| | **Stalk**- in crouch slowly move towards „prey“ |
| | **Pounce**- short jump onto conspecific or other being/object |
| | **Swat**- paw rapidly extends and retracts toward conspecific or object |
| | **Bite**- mouth closes on object |
| | **Startle**- quick, short movement/jump away from conspecific, object or noise |
| | **Hiss**- exhalation of air, teeth bared, ears back |
| | **Growl**- rumbling in throat, teeth bared, ears back |
| | **Grunt**- short low pitched sound, ears forward |
| | **Roaring**- repeating grunting sound, beginning very loud & strong and fading away |
| | **Drink**- lapping up water and swallowing |
| | **Urinate**- relieving bladder |
| | **Defecate**- relieving colon |
| | **Sneeze**- quick exhalation of air through nostril, quick shake of head |
| | **Groom**- licking fur |
| | **Scratch**- moving paw with claws extended across self or object |
| | **Sniff**- inhalation of air directed at object or conspecific |
| | **Spray**- short spurt of urine, may or may not be preceded y pawing of ground by back feet |
| | **Rub**-rub head on conspecific or object |
| | **Flehmening** response- sniff, then lift head open, mouth tongue out, breath in |
| **Breeding** | Mating bout- includes, according to sex, at least Mounting or Being mounted along with other breeding behaviours sequentially |
| | Rolling- see roll above, female will roll after mating |
| | Rubbing head- see rub above |
| | Rubbing perineal area- rubs perineal area on conspecific or object |
| | Lick/Groom mate- conspecific licks or grooms mate before or after mating (during mating bout) |
| | Lordosis- similar to crouch but with rear lifted and tail held to one side exposing perineal area (female) |
| | Mounting- male moves on top of female in lordosis |
| | Being mounted- when female in lordosis is mounted by male |
| | „Getting under“- female walks in front of male and goes into lordosis |
| | Low growl- growl but softer sounding usually without teeth bared or ears back |
| | Auto-grooming- female grooming of perineal area |
| | Scent marking/urinating- see spray/urinating above, male performs behaviour after mating |

*Figure 3 - Lion pride eating a prey at night (by Michael Nichols)*

*Figure 3 – Lion pride resting during the day (by Michael Nichols)*

***Example 2 - Cheetahs natural behaviours***

On the contrary, Cheetahs (Acinonyx jubatus) are daylight hunters. Diurnal, meaning they hunt in early morning and late afternoon, their spotted coat allow them to blend easily into high and dry grasses. Female cheetahs typically live with their litter composed of three cubs, while male cheetahs live alone or in small groups, often with their littermates. They are adapted for hunting and are the world's fastest land mammal, so they don't need to work as a team to hunt. However, after a sustained effort in chasing and killing their prey, cheetahs may rest for around half an hour before they begin to eat. Cheetahs will then spend most of their time sleeping and are minimally active during the hottest portions of the day.

*Figure 4 - Cheetah hunting a prey at the sunset (by Roie Galitz)*

*Figure 5 – Cheetah Female and her cubs resting during the day (by Michael Poliza)*

Those 2 species demonstrate that even relatively close species who are both felids and who share the same habitat, are hunting the same animal species, have quite different lifestyle, one living mainly in pride and the other primarily solitary. Therefore, they might have quite similar ethograms but have different natural behaviours and social needs. A significant difference was found between proximity while resting. Leopards are solitary and rested far from

each other while lions are the only truly social felid rested in close proximity to each other in large groups.

Preserving behavioural diversity according to species is a challenge as the captive environment can never fully duplicate their natural habitat. In response, animals have shown a behavioural flexibility and a capacity to adapt to captivity, to cope with their environment. Potentially, over several generations, this can result in genetic and phenotypic divergence between captive and wild populations. Therefore, natural behaviours can vary between the two. It should be noted that sometimes animal may perform certain behaviours even if they don't need the outcome and is seen for example when animals keep hunting even when satiated, or when continuing to build new nests and presenting multiple fully formed nests.

### 1.3 Abnormal /Stereotypical Behaviours

Behaviour is the animal's "first line of defence" in response to environmental change; it is what animals do to interact with, respond to, and control their environment (Mench, 1998). One possible method of using behaviour as an indicator of welfare is too look for abnormal behaviours. By abnormal is meant a persistent, undesirable action, shown by a minority of the population which is not due to any obvious neurological lesion and which is not confined to the situation that originally elicited it (Broadhurst, 1960 ; Fox, 1968 ; Meyer-Holzapfel, 1968). Abnormal behaviours are also called stereotypical (or stereotypic or stereotyped) behaviours. It is described by Turner (1999) as involving repetition, rigidity and invariance as well as a tendency to be inappropriate.

Captivity limit their ability to control the external stimulation to which they are exposed (Carlstead, 1996). Possessing an element of control is essential for animals to be able to adapt to their environment and to support their well-being (Sambrook & Buchanan-Smith, 1997).

There is a very wide range of behaviour patterns which are called abnormal or stereotypical. Captive animals in unsatisfying or understimulating environments have little to occupy time but keep some strong behavioural needs. Frustrated by a restrictive environment, they are prevented from doing something that they are highly motivated to do, and this results in boredom. To fill this void, animals attempts to cope with suboptimal environment by expressing negative emotions and reduced behavioural diversity. This coping mechanism is seen by the development of repetitive pacing especially in carnivores, „trunk suck" movement

in elephants (figure 6) tongue-playing by giraffes (Giraffa) (Figure 7), aggression, excessive sleeping/dozing or inactivity (apathy). Occurrence of fear behaviours can be indicative of stress, depression and therefore low welfare as well. At the extreme end are patterns which involve cannibalism and self-mutilation such a toe-pecking in chicks, feather-plucking in birds (figure 8) , fur-plucking in rodents or primates, leading to physical damage and in some cases even death.

For those reasons, it is important to give opportunities for animals to perform as many behaviours as possible, either natural or non-natural, increasing their diversity and this way the development and frequency of abnormal and stereotypic behaviour should be prevented or at least reduced.

*Figure 6 - „trunk suck" movement in elephants as a cooping mechanism (Schwilp, 2019)*

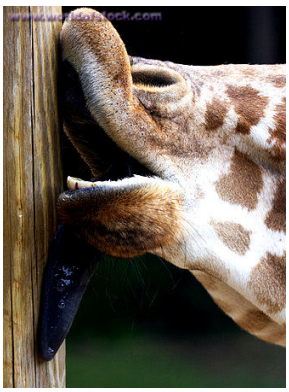

*Figure 7 – Tongue playing by a giraffe (https://www.awjac.org/docs /2010_Giraffe-Scenario.pdf)*

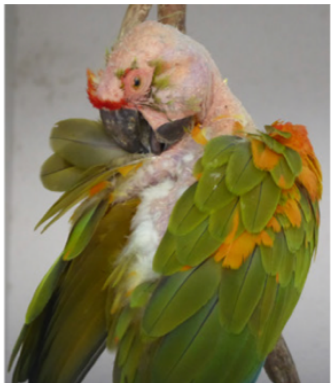

*Figure 8– Feather-plucking in a red-fronted macaw (Ara rubrogenys) (Rose and Riley, 2019)*

## 2. Different types of enrichments to improve animal welfare

To increase the panel of behaviours in captivity, it is recommended to provide a variety of stimuli to the animal's environment or to change the environment itself. It is called behavioural or environmental enrichment.

Initially, environmental enrichment is expected to :

- increase species-specific behaviours, behavioural diversity, flexibility and exploration
- reduce abnormal and stereotypic behaviours
- reduce the disparity between wild and captive animal behavioural repertories
- reduces negative emotional states (fear, stress, boredom, apathy, frustration)

(van Hoek and King, 1997 ; Carlstead and Shepherdson, 2000 ; Hunter et al., 2002 ; Swaisgood and Sheperdson, 2005; Moreira et al., 2007)

Indeed, Viktor and Annie Reinhardt (1998) describe enrichment as "the provision of stimuli which promote the expression of species-appropriate behavioural and mental activities in an understimulating environment".

Several studies have found that enrichment effectively decreases stereotypic behaviour, with 90% of studies found significant effect of enrichment, reducing stereotypic behaviours compared to baseline conditions (Shyne, 2006 ; Mason et al., 2007 ; Swaisgood and Shepherdson, 2006), In a group of captive giant pandas (*Ailuropoda melanoleuca*), Swaisgood et al. (2001) also demonstrated that five different enrichment devices, including puzzle feeders and manipulative plastic objects, had as a consequence a increased exploratory activity and decreased amount of time spent in anticipatory stereotypic behaviours.

But implementation of environmental enrichment by offering a complex environment, has significant impact on non-behavioural parameters and improved biological function too. It has been demonstrated to have a many other benefits (Barnard et al., 1996 ; Healy and Tovee, 1999; Young and Cipreste, 2004 ; Carlstead and Shepherdson, 2005) :

- increase lifetime
- increase reproductive success
- increase physical activity and physical health
- increase brain development, cognition stimulation
- improved recovery after surgery (trauma)

As a result, environmental enrichment is known to effectively improve animal welfare.

However, it is not always helpful to recreate all natural stimuli for a couple of reasons. Consider that not all natural behaviours in the wild are indicative of good well-being. Fear, stress, disease and death are frequent experiences that wild animals come across. Simply mimicking nature is therefore not acceptable to base enrichment initiatives.

Key concepts behind environments that promote good welfare are complexity and novelty, choice, and control, and their relationship to predictability (Buchanan-Smith, 2010). These concepts underpin Poole's (1998) four basic needs of mammals, namely security (a safe area in which to rest and feel secure), complexity, achievement (control), and novelty (to satisfy curiosity and prevent boredom).

Enrichment can be active versus passive. Active enrichment requires the animal to perform some physical activity or direct interaction with the enrichment increasing the animal's activity budget. Those are more prone to habituation and require more variation than passive enrichment. The latest stimulates the animals' senses, does not involve interaction, direct contact or control, and can simultaneously be enriching for several animals.

Different types of enrichment are available and can be classified in different categories (figure9&10). Here are the most common environmental enrichments types :

- **Physical Habitat / Structural**
- **Nutritional / Food-Based / Food-related**
- **Sensory – Auditory / Olfactory / Visual**
- **Cognitive / Manipulative / Tactile**
- **Social**

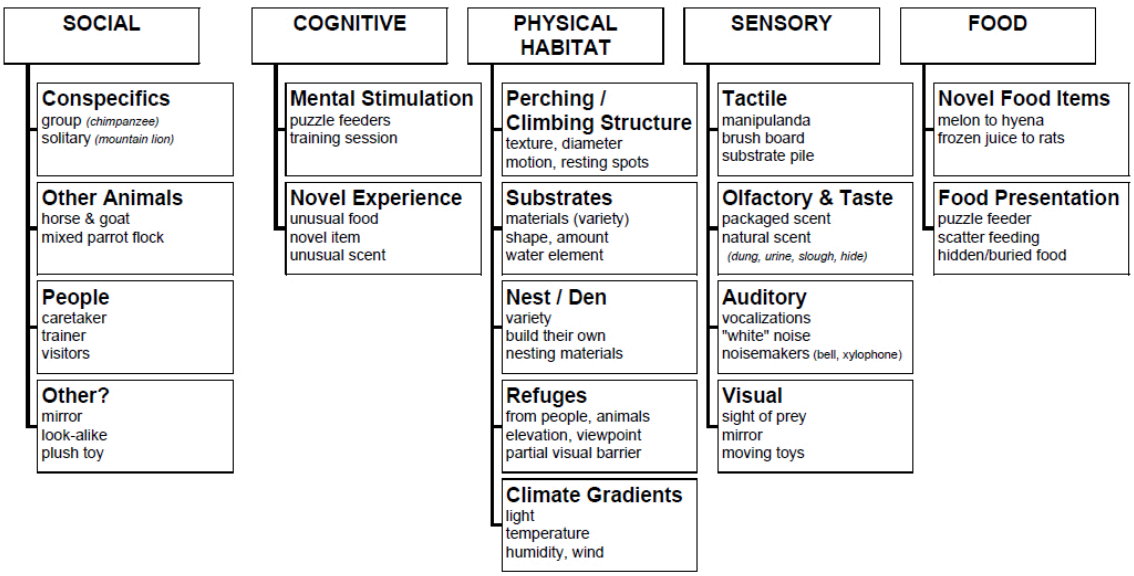


*Figure 9 – Examples of enrichments according to the different categories*

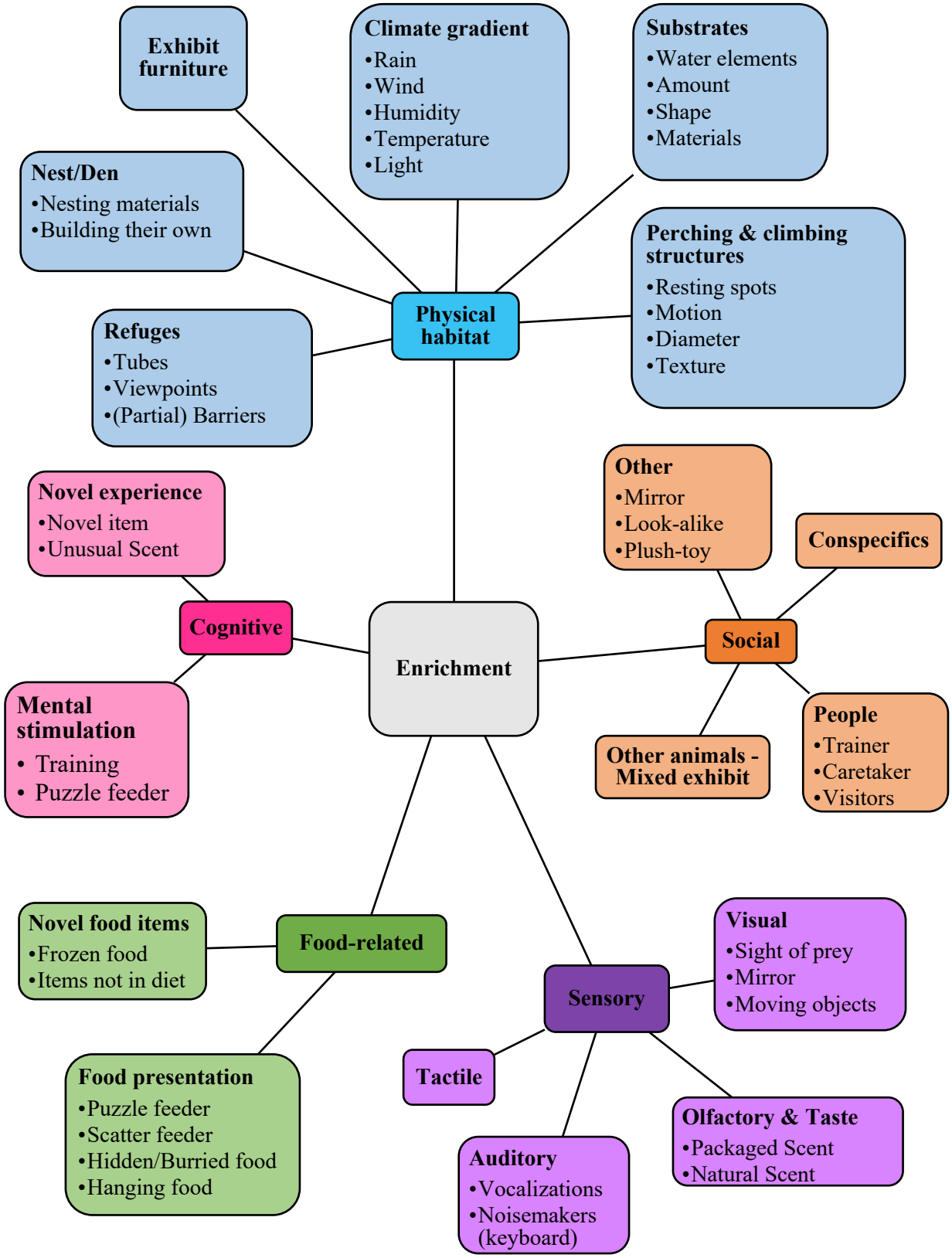


*Figure 10 – Summary of the enrichment diversity (inspired by Zoosnippets)*

Some seem to be more important than others when looking animals' responses to stimuli and is shown in Figure 7. Numbers and names of categories can vary but those are the most commonly used. Also it should be noted, enrichments are non-exclusive and can involve more than one category.

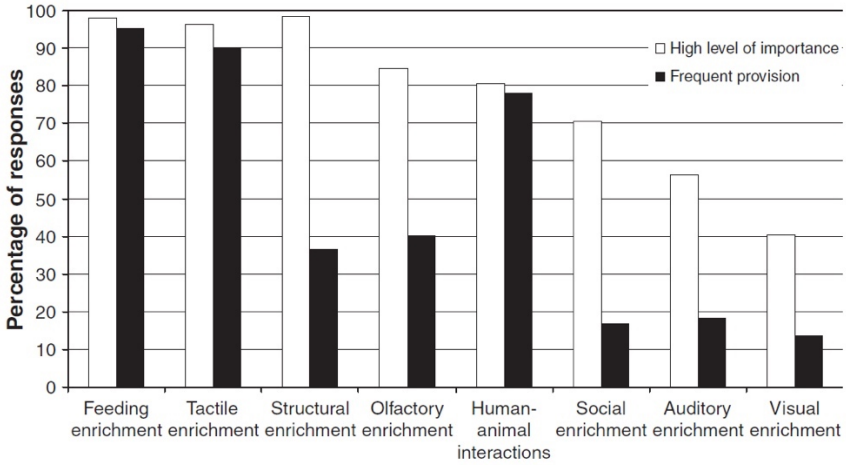


*Figure 11 - Comparison between the perceived importance and actual frequency of provision of the different types of enrichment. A "high level of importance" is the total percentage of responses of "very important" and "important. "Frequent provision" is the total percentage of responses where enrichment was provided more than once during the week (Hoy et al, 2010)*

**2.1. Physical habitat / structural :** Alteration of the physical space of enclosure, natural and artificial structure, water element, substrates, climbing structure, refuge, nest, den, climate gradients

The main goal is to stimulate animals' exploratory behaviours, trigger them to collect information about their habitat, and keep them physically healthy by encouraging them to be more active. The physical environment should be frequently altered and switched so animals do not become too familiar with their environment, which causes boredom and can eventually cause stereotyped behaviours.

Habitat can increase physical challenge, have direct physical benefits by increasing levels of interaction and mobility. Animals are likely to have stronger muscles, higher endurance, or better balance, but also improve long-term physical health and fitness.

The size and visual appearance of the enclosure if important, and its complexity can also be enhanced by non-linear division into more or less isolated areas. Permanent and temporary structures must be present. Think of balance plateaus, wobbling climbing structures, various reliefs, rocks overlooking the enclosure, shade, shelter to hide, beams and perches,

herbaceous or shrubby or arboreal plants, swamps or mud puddles, trunks, etc. Figure 12 is a typical enclosure for macaques (Macaca).

*Figure 12 – Macaque enclosure enriched through the addition of windows, wire mesh and multi-levelled climbing structures (https://www.nc3rs.org.uk/macaques/captive-management/enrichment/)*

Leopard cats, Felis bengalensis, living in virtually barren cages had chronically elevated glucocorticoids and high levels of stereotypic pacing that decreased dramatically when they were given the opportunity to hide or conceal themselves in newly provided complex furnishings and vegetation. They also increased the amount of time spent exploring their cages. (Carlstead, Brown and Seidensticker 1993).

**2.2. Nutritional / Food-Based / Food-related :** Manipulation of food, changes in feeding methods and time, scattered feed, frozen food, hidden food, hanging food, whole food, live food, puzzle feeders

Each animal species has developed a specific diet that depends what food is present on its natural habitat and the presence of rival species. These ecological pressures have shaped animals' food foraging behaviour. A species' natural food types must be respected for the welfare of animals held in captivity (Newberry 1995; Young 1997). In addition, a food distribution system taking into account sub-groups or groupings present help determine optimal distribution locations and numbers. This will prevent aggressive encounters and reduce overall stress levels (Buchanan-Smith *et al.* 2013).

Moreover, feeding in the wild constitutes a large portion of some species' activity budget, namely 80 to 95% of their time when not resting or sleeping. Foraging and hunting are processes that include searching, acquiring (harvesting or capturing and killing) and consuming food items (Lindburg 1998). However, time spent on consummatory behaviours in captivity in comparison with their wild conspecifics is generally enormous.

Providing a novel food item helps stimulate and extend the appetitive and consummatory behaviours of an animal. But when the food is offered ready-made, the perspective of hunting, finding, exploring, reaching and consuming is completely lost. Captive animals, rarely have opportunities to do anything but consume, as food is reduced from a complex (eg. An intact prey item) to an overly simple form (eg. Pre-processed meat). A huge profit is visible when we stop providing free food and make feeding more challenging. Enrichment in the form of provisioning with the whole carcasses increases handling time of food and reduces time spent in stereotypic pacing (McPhee 2002).

Distribution of food at random times and throughout the day is a temporal nutritional enrichment. And spatial food distribution has a major effect on the duration of feeding, scattered food increasing foraging and decreasing stereotypic behaviour compared to clumped food in captive Sun Bears (Barber et al., 2017) (Figure 13 & 14).

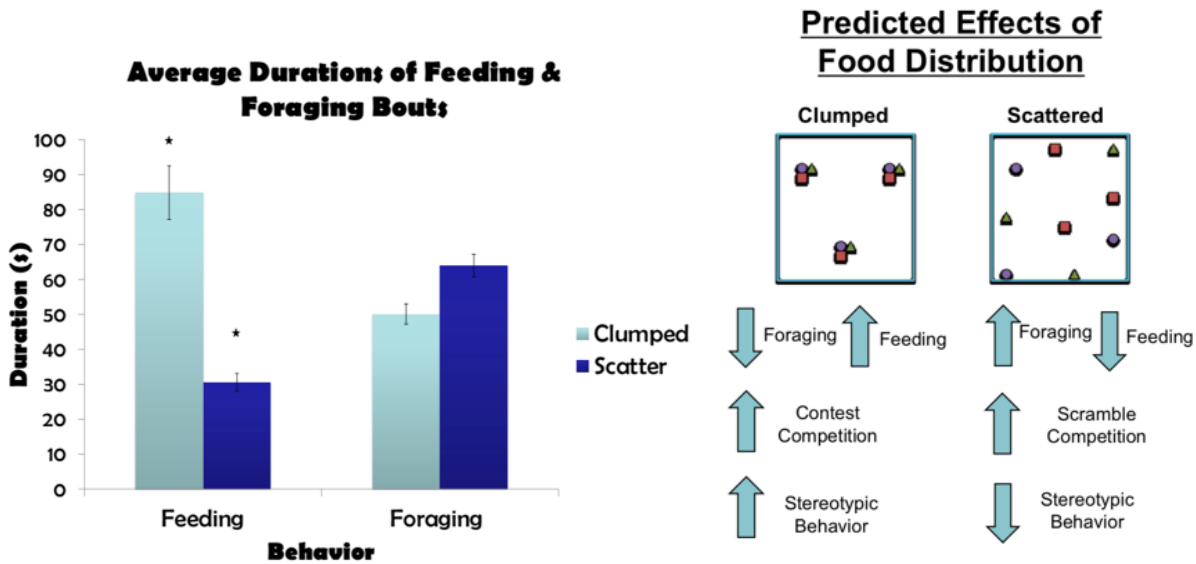


*Figure 13 & 14 – Comparison between Clumped and Scattered food distribution's influence on behaviours (Barber et al., 2017)*

Food-related enrichment is one of the most common with structural enrichment. Foraging enrichment typically has physical features like food searching and consumption. However, where wild animals also need different levels of analysis when acquiring food, many

enrichment programs do not include the integration of cognitive challenge in the design of food enrichment. For insectivores, crickets or larvae (or seeds) can be put into tubes placed high up; as they move the insects will gradually fall to the ground, increasing the animal's foraging behaviour. The same result can be achieved by putting insects in the middle of box filled with pine cones or a box with holes for example like in figure 15.

*Figure 15 - Brush insect feeding box used by Meerkats (Suricata suricatta)*
*(https://www.zoosnippets.com/post/the-contrafreeloading-concept-what-does-it-mean)*

Female African elephants (Loxodonta) who experienced a wide variety of enrichment opportunities and feeding options, such as puzzle feeders, were more likely to have normal reproductive function (Meehan et al., 2016). This result indicates that setting enrichment up, could be an important tool in addressing the reproductive issues, particularly common among female African elephants.

When African lions (*Panthera leo*) and Sumatran tigers (*Panthera tigris sumatrae*) were given large animal bones and live fish, changes on the behaviour was observed. Non-stereotypical behaviour, including play, was recorded to increase by as much as 50% from baseline levels (Bashaw et al., 2003)

For animals in conservation programs which will be released into the wild, to increase population numbers for the purposes of preserving the species, presenting predatory species with live prey to stimulate their senses, cognitive capacities and motor capacities can be an option (People Le Ruyet *et al.* 1993; Young 1997; Bashaw *et al.* 2003). But the type of predator and prey should be considered as this type of enrichment raises health risks and ethical concerns. We must ensure that the predator kills the prey quickly and efficiently so as to limit its stress and pain.

**Contrafreeloading**

Surprisingly animals also tend to show behavioural need to work for their food. This phenomenon is called **Contrafreeloading**. This behaviour seen in most animals, when an animal is offered a choice between free food or identical food that requires effort, the animal prefers the food that requires effort (Glen Jensen, 1963 ; Clark and Melfi, 2011 ; Li et al., 2009 ; McGowan et al., 2010) like pole feeding in felids (figure 16). Within zoos it is applied as diet offered with the help of devices, substrate or locations to decrease or even completely remove free feeding to ultimately extending foraging time (Maple and Perdue, 2013). For example, maned wolves (*Chrysocyon brachyurus*) were provided scattered food around the enclosure (which require work to gain) simultaneously with food on a tray (free). Wolves preferentially chose 'hard to get to' food (Vasconcellos et al., 2012)

*Figure 16 - Tiger pole feeding, climbing to reach food (Malpass Oz Adventure. 2011)*

**2.3. Sensory :** Addition of natural or artificial sounds/odours/visual stimuli ; mirrors, reflectors, music, animal vocalizations, noisemakers (keyboard/squeeze ball), perfume, herbs or animal scents, sight of prey, scratch poles

Sensory enrichment is mainly passive and focuses on stimulation of one or several animals' senses : sight, hearing, touch, taste and smell. These means of communication are used by animals to gather information about the surrounding environment when there is enough

variety in it. Enriching the senses via visual, auditory, olfactory and somatic environmental complexity reduces negative behavioural (e.g. stereotypies, inactivity) and psychological (e.g. anxiety, depression) effects of captivity (McPhee and Carlstead 2010).

### 2.3.1. Visual enrichment

Animals in zoos can be kept in enclosure allowing them to see outside, have an overlooking view, and be able to see the horizon. They are then stimulated by seeing visitors and/or other animals. Although this can be stressful for them in some situations, which is why providing them with an area where they can isolate and hide in important. Used as a last resort when animals need to be isolated for health reasons to replace social interactions, the animal can be stimulated by radio, computer or television, which can also elicit sensory behavioural reactions. This would be a temporary solution as animals will quickly get used to this stimulus and this only meets the minimum conditions of welfare. If possible, the animal must be able to turn the device on or off by itself, so as be calm or stimulated when it wishes.

Mirrors can trigger some active and natural behaviours too, depending on the species and their cognitive capacities (Gallup Jr et al. 2002). For species not recognizing themselves in the mirror (no self-awarness), the mirror creates the illusion of there being more individuals in the pen, which can increase the individual's welfare and reproduction, as has been shown with flamingos (O'Connel & Rodwell 2004) and rabbits (Jones et al. 2005). However, it has been observed that reflection of an elephant in the window of an exhibit elicited stress every time he would see himself. Great apes, which are able to recognize themselves in the mirror will spend time using it to inspect parts of their bodies that they usually cannot see (behind, inside mouth). Nevertheless, it is not advisable to place a mirror in front of gorillas (Gorilla sp) because this species sees direct eye-to-eye contact as an aggression. Direct visual contact is also a threat for many monkey species. Threaten and daunted, they will show attacking behaviours. This could be considered as social enrichment without inflicting any damage or harm to other animals but might inflict stress.

*Figure 17- Gorilla's aggressive reaction when looking at his reflection in a mirror (https://i.ytimg.com/vi/ZwkXtrfHz4s/maxresdefault.jpg)*

*Figure 18- Curious Zebra looking at his reflection in a mirror (https://www.zoosnippets.com/static/img/active_vs_passive_enrichment.jpg)*

### 2.3.2. Auditory enrichment

Auditory sensory enrichment consists of playing sound (natural, music, radio), but as television, these stimuli shouldn't be played continuously, but only for several minutes a day or a week, otherwise risking to be more harmful and stressful than enriching. Auditory enrichment can stimulate acoustic „prey" (Markowitz, Aday, & Gavazzi, 1995). Sound recordings can also be very stimulating for species with a vocal repertoire including songs like in gibbons (Hylobatidae) and passerines (Passeriformes). The same is observed in animals which communicate through vocalization like wolf (Canis lupus) howl and deer (Cervidae) bellow.

As music can have a positive effect on animal welfare, it also affects production. It has been shown that cows produce more milk when music, especially classical, is played (Albright & Arave, 1997). Many species are also able to recognise a beat and enjoy rhythm, such as seals (Pinnipedia) (Cook *et al.* 2013) or parrots (psittacines) (Patel *et al.* 2009). Behavioural research has also shown that a chimpanzee hitting or beating a barrel followed a rhythm similar to rhythms produced by humans (Dufour et al. 2015). Radio music made available to singly housed baboons (Papio hamadryas and Papio hamadryas-anubis hybrid) also significantly lowered heart rate, but had no observable effect on behaviour or blood pressure (Brent and Weaver 1996). Although cotton-top tamarins (Saguinus oedipus) and common marmosets (Callithrix jacchus) have been shown to prefer slow tempo music to fast tempo music, they also appeared to prefer silence to music (McDermott and Hauser 2007). Because few researches

have been done on so few species, findings are conflicting, it is difficult to draw conclusions regarding musical preference(s) or music's beneficial physiological and behavioural effects

### 2.3.3. Olfactory enrichment

Olfactory (smell and taste) enrichment consists in stimulating the animals with unfamiliar natural or chemical odours. This could just be branches or trees cut for clearing but placed in the enclosure which will release a special smell, or items with specific odours of various spices and plants or other predatory, prey or neutral species. It can commonly elicit several active behaviours and can easily be implemented. Shuangying (2008) provided Amur leopards with three effective odours of prey species, sympatric carnivores, and spices. Felids, is one of the family that seem to benefit the most from it, and show many behavioural responses such as marking, scratching, rolling on and rubbing against scented objects.

### 2.3.4. Tactile enrichment

Tactile sensory enrichment consists of giving an animal various permanent or temporary substrates with different textures or grains and with which they may interact in the nature but also novel for them. For example sand or straw can be used for animals that look for food on the ground, mud for animals that like to cover themselves with it, access to water with river, pond or automatic water misters for animals that like to bathe. Placing food like fish for bears or otters (figure 19), seeds for granivores, meat for felines, fruit and vegetables for primates, and others (or objects) in ice, is commonly used, especially by hot weather to cool them down and stimulate tactile and nutritional enrichment. Ice baths containing ice cubes can also be proposed.

*Figure 19 - Otters feeding enrichment with fish in a big ice cube (https://dailyotter.org/posts/2018/7/25/otters-get-an-icy-tasty-enrichment-activity)*

**2.4. Cognitive / Manipulative :** Novel-item/object, puzzle feeder, ball, bags, toys

This type of enrichment is described as cognitive and mental stimulation that requires problem-solving of different levels of complexity. Often associated with food enrichment, the most used devices are puzzle feeders where animals are mentally engaged and rewarded by food. However, to keep the cognitive component of puzzle feeders, they must be modified and updated regularly, or you need a (very) large variety of them. Animals with a higher form of intelligence need to be even more mentally stimulated to excite their cognitive abilities. It is even seen that animals actively seek for novel stimuli, where it visits places where it can expect novel objects (Wood-Gush and Vestergaard, 1991)

Chimpanzees can feel a certain sense of well-being by holding and using a pen or painting on paper with their fingers or even brushes (figure 20), even if chimpanzees do not paint in their natural environment (Watanabe 2012). They may also use sticks as tools to look for ants or termites in collectively built tunnels, break nuts open using selected stones called hammers or anvils (McGrew 1974).


*Figure 20 - Chimpanzee painting*
*(https://janegoodall.nationbuilder.com/archive-gifts_for_chimps)*

This can be adapted to all types of animals, not just mammals and birds, but also reptiles, fish, molluscs etc. like seen with a Giant Pacific Octopus (Enteroctopus dofleini) solving a prey puzzle try to open a hamster ball containing fishes (Figure 21 & 22 by AZA).

*Figure 21 - hamster ball containing fish*

*Figure 22 – octopus opening the hamster ball containing fish*

**2.5. Social :** Conspecifics, Mixed-exhibits, Addition of removal of animals from an enclosure, Human-Animal Interaction with keepers and visitors, Positive reinforcement training, Plush toy (Substitute of social enrichment)

In the wild many species live in social groups or flocks. Interaction with members of their own species or other species encountered in the wild is essential. Whatever its degree of sociality, an animal's social interactions and structures, has a huge impact on its health, welfare, ability to reproduce and longevity (Price & Stoinski 2007; Silk & al. 2003; Stanton & Mann 2012). It has been demonstrated in several species that investment in the development of long-lasting stable relationships has a positive effect on the animal's quality of life and reduces their stress levels (Archie & al. 2014; Fürtbauer & al. 2014). Indeed, research on baboons in their natural environment showed that the stability of social relationships had a positive impact on their health and welfare (Silk & al. 2009). Uvnas-Moberg (1998) also believes that social stimuli leads to increase in oxytocin, which has health benefits such as weight gain and lowering of blood pressure in laboratory-housed rats. Such results highlight the potential benefits of positive social experiences and the importance of including physiological aspects of animal behaviour.

Social enrichment consists of housing a group of conspecifics (social group) or animals of different species that would encounter in the wild as well (mixed-species groups), and secondly social enrichment consists of stimulating species-specific social behaviours. When animals are placed in groups it is vital that the space is big enough for individuals to stand apart or escape their pen-mates if wanted. Social enrichment is often an underused category of

the enrichment repertoire, as seen in the study of Hoy, Murray and Tribe, 2010, although considered as very important.

### 2.5.1. Group of conspecifics

In captivity, animals are kept in natural group size with a sex-ratio and hierarchy as seen in the wild, as often as possible. Reproducing natural social groups give them good chance for social interactions and stimulate natural behaviours. Compatible conspecifics are known to buffer stress (e.g. Smith et al., 1998), and present opportunities for positive welfare enhancing behaviours such as, playing, mating and grooming like the East Javan langur (Trachypithecus auratus) seen on figure 23 . Allowing individuals to choose to spend time together or apart, is likely to be the most important welfare consideration though.

In the case of meerkats for example (figure 24), a larger group of animals with a partly equal sex-ratio and a leading alfa couple is recommended. To experience lower stress when sleeping or foraging, one or several lower ranked meerkat will guard the group. The situation is the same for flamingos, which are also best kept in large groups, for often the same reasons as meerkats. The rule apply with many hoofed mammals too.

*Figure 23 - East Javan langur grooming* (https://www.zoosnippets.com/static/img/group_of_primates_2.jpg)

*Figure 24 – Meerkats mob resting (https://www.monartosafari.com.au/animal-experiences/meerkat-mingle)*

### 2.5.2. Mixed-species groups

As species do not live in isolation from each other in the wild, the formation of multi-species groups that naturally associate may also improve welfare (Chapman & Chapman, 2000 ; Leonardi et al., 2010 ; Buchanan-Smith *et al.,* 2013 ; Daoudi et al., 2017). Individuals from different species will either simply share the space without developing any particular

relationship, as is the case of hoofed 'Savannah' animals, Zebras and antelopes, or or share the same space but also develop social and relationships and groom each other (Pearson *et al.* 2010).

For example, there are potential advantages of housing primates in mixed species exhibits if naturally associated in the wild. It increases social complexity and stimulation which is enriching for the primates as studied with capuchin monkeys (Cebus apella) and squirrel monkeys (Saimiri sciureus). Those two species gain foraging benefits and lower predation. No evidence of chronic stress was found and Saimiri actively chose to associate with Cebus. In carefully designed, large enclosures, naturally associating monkeys are able to live harmoniously and are enriched by each other. (Leonardi et al. 2009)

However, social enrichment isn't as common as structural enrichment for example, due to potential harms, including problems with introducing individuals, risks of disease transmission and concerns about territoriality and competition for dominance which is a natural social behaviour but associated with risks of serious injury. When animals are mixed in the enclosure there should be enough space and hide-outs (Goltenboth et al., 2001). Mixed species should be carefully chosen. White rhinos can be kept with zebras, giraffes, ostrich and wildebeest for example (Figure 25 by EAZA), but not with elephants, zebra bulls, and wildebeest bulls as it would be very risky even in a big enclosure.

*Figure 25 - Rhino, ostrich and zebra in mixed exhibit*

In unfortunate situations when animals have to be isolated for health issues and can't be in contact with others, it is necessary to keep socially stimulating then. First of all, animals held in separate cages must be able to see each other. This visual contact is vital for social animals (Bayne *et al.* 1993). Under such conditions, interaction with animal handlers is advised, especially with species that have advanced cognitive capacities, such as monkeys.

### 2.5.3. Objects as social enrichment

In many zoos, it is not possible to keep the complete natural social structure of groups of animals in captivity, due to lack of space or availability of animals. Other social enrichments therefore needed, to stimulate species-specific behaviours such as feeding, foraging, territoriality, reproduction and courtship. Another way of social enrichment are look-a-likes or plush toys, helpful when a young animal has been rejected by their parents for example. It can be very beneficial for him to focus less on humans but on the plush toy penguin instead. This allowed keepers nurse a young penguin to accept fish-feeding by hand. Adult female chimpanzee has also shown interest and found security from a plush toys as demonstrated by on figure 26.

*Figure 26 - Chimpanzee interested in a plush-toy*
(https://projectchimps.org/donated-plush-chimp-toys-bring-joy/)

### 2.5.4. Human-Animal interactions

The importance of human presence and contact with isolated animals should not be underestimated. Humans are inevitably a critical part of the lives of all captive wild animals, and their actions are controversial as they can impact animal welfare positively and negatively, or sometimes have no impact (Cook and Hosey, 1995).

Firstly, a negative relationship is considered to exist if the animal is highly fearful of humans and avoids contact or proximity with them. A 'neutral' interaction has been described as an animal that shows low levels of fear towards people but still avoids contact with them. And finally, a positive relationship may exist if an animal is not fearful and instead shows some confidence with people (Waiblinger et al., 2006).

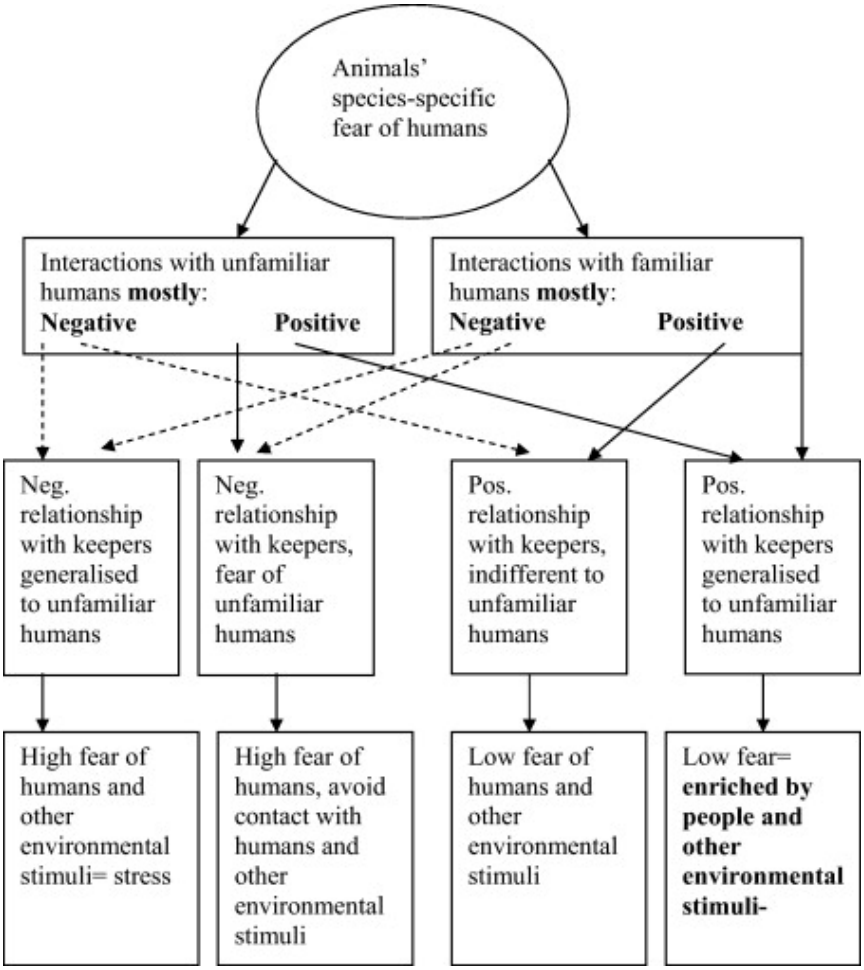


*Figure 27 - A model of human–animal interactions and their consequences for human–animal relationships in zoo animals (Claxton, 2011)*

A human-animal relationship can be defined to exist if a number of repeated interactions between the same animals and humans occur, eventually allowing each party to make predictions about the others behaviour (Hinde, 1976). Those interactions are shown to be influenced by the animal's genetic structure and the environmental conditions during rearing, including levels of prenatal stress (Clarke and Schneider, 1993 ; Braastad, 1998).

Interaction between humans and animals are various and provide animals with stimuli during routine husbandry, during entertaining shows, directly with visitors through windows, during behavioural experiments and during animal training including medical training.

A review of this topic by Claxton (2011) concluded that there were some elements of zoo human-animal interactions might be considered to be enriching. Bayne et al. (1993) have shown that only six minutes per week of human presence significantly decreases stereotypic behaviour in individually housed rhesus macaques (Macaca mulatta) for example.

### 2.5.4.1 Entertainment show and visitors

Visitor initiated interactions towards zoo animals appear to have different impact depending on the species, the type of visitors and the number of other factors (Hosey, 2000; 2008). The presence of tourist can be a source of stress, enriching or can have no impact at all (Hosey, 2000; Hosey & Melfi, 2015). For example, a negative impact is noted on primate species and little visible impact on felids. Primates never completely habituate to the presence of visitors and express new behaviours toward public ( Hosey & Druck, 1987 ; Chamove et al., 1988). On the contrary, the presence of visitors has been described not to affect adult female cheetahs and cubs' behaviour and reproduction. They seemed to quickly recognize and adapt to potential threats in a study by O'Donovan et al. (1993). Moreover, when animals face unfamiliar faces for a short time, animal don't have the time to build any kind of relationship, and the high level of unpredictability of such contact may be a source of stress, particularly as visitor behaviour may vary in density and stimulus.

It is also shown that stress caused by large groups of visitors can be reduced by the design of their enclosure, its position and provision of boundary rail to lower interactions but allowing visitors to still see the animals for example. Increased agonistic behaviour and decreased inactive and grooming behaviour in ringtailed lemurs (*Lemur catta*), cotton-topped tamarins (*Saguinus oedipus*) and Diana monkeys (*Cercopithecus Diana*) was recorded by Chamove et al. (1988) when visitors were present. However, when visitors were asked to crouch rather than stand in front of the enclosure, unwanted behaviours reduced. In contrast, a study about three short-clawed otters (*Aonyx cinerea*) showed an increase in play and feeding in the presence of zoo visitors, which was considered evidence that visitors had a positive effect on the animals (Owen, 2004)

Broadly, this topic is controversial as both positive and negative impacts are visible as many factors should be taken into consideration. Although many researches done highlight the negative impact of visitors on captive animals (Hosey, 2013; Lambeth et al., 2000; Wormell et al., 1996), human-animal interactions should be considered case by case.

### 2.5.4.2 Behavioural experiments

Behavioural experiments uses comparative psychology and ethology. These tests are regularly renewed and access advanced cognitive capacities such as recognising numbers, colours and symbols, opening enticing boxes using tools or the capacity to exchange elements of different values (Tomasello & Call 1997; Pelé et al. 2009).

*Figure 28 - Crocodiles being trained to recognize colours*

### 2.5.4.3 Training

Training increases human–animal interactions through and beyond those encountered during routine husbandry. There is value in considering whether training zoo animals is enriching, from both a theoretical and practical perspective. Training zoo animals is for some species essential, and for others to be avoided.

Keeping that fact in mind, any animal can be trained, even those we do not think of as intelligent. Ken Ramirez, for example, once trained 10,000 butterflies for a show where the insects flew en masse, on cue, from one location to another in three different groups, at three different times.

For the anecdote, training can be used in different ways and we can train wildlife to act like wild animals to be rehabilitated. Animal trainers working to conserve wildlife often have the opposite goal: teaching animals in the wild to avoid human beings, meaning decreasing human-animal interactions, people often being the most dangerous creatures in the nature. Ken Ramirez worked with polar bears to draw them away from towns and into wild habitat. When bears were spotted coming into towns to forage firecracker shells were shoot off to be frightened but had no long term-effect. Ramirez advised habitants to wait and scare the bears once they touched something human, a garbage, a fence or a truck for example and not when they were spotted on a road. This project helped lower incidents from 300 to less than 10 a year.

Going back to training increasing human-animal interactions, it is important to have an evidence based approach and to understand the implications of making changes to animals' lives.

Training can be considered as part of social and cognitive enrichment, because of the **mental stimulation and cognitive challenges** provided. It can be beneficial by increasing social play, decreasing inactivity, and mitigating social aggression during feeding as well.

Polar bears (Ursus maritimus) are known to exhibit high stereotypic repetitive pacing behaviours caused by boredom in zoo environments. A study held in North America (Shepherdson et al, 2013) showed that higher faecal glucocorticoid metabolites levels were associated with higher proportions of stereotypic pacing, low interest and activity, and smaller dry land exhibit area. Variables associated with reduced pacing were: environmental enrichment having a view out of their exhibit, and social enrichment such as number of bears in the group. Findings also suggest that positive reinforcement training program, can possibly reduce the incidence of stereotypical behaviours.

In another study by Wielebnowski et al. (2002) with adult clouded leopards (*Neofelis nebulosa*) a negative correlation between faecal corticoid levels and the amount of time primary caretakers spent with the animals has been observed. In contrast, there was a positive correlation between cortisol levels which was high when animals demonstrated more undesirable behaviours such as self-directed mutilation, and the number of keepers. These findings indicate that the quality of the relationship is important and intense rotations of keepers can have a negative effect.

Training goals can be quite diverse: moving animals to a precise area to separate them, or feeding them safely for example. There is evidence that many species, including mammals, birds and reptiles can be trained to move within their enclosure readily and reliably on cue (Young and Cipreste, 2004). Some consider then training to be enriching because it **facilitates the provision of conventional environmental enrichment,** as it helps to efficiently and successfully move animals to other areas of their enclosure, allowing keepers to enter to provide, refill, or remove conventional environmental enrichment.

Training can be considered enriching because it affords **learning opportunities**, and learning is considered to be enriching. Learning is defined as a change in behaviour resulting from practice or experience, and when dictated by humans it is termed training (Mellen and Ellis, 1996). Studies have demonstrated that active learning in animals is associated with many

benefits including improved brain form, function and development (van Praag et al., 2000) and increased ability to cope within the environment (Carlstead, 1996). But once the animal can perform a behaviour on cue, it is no longer an active learner and the behaviour becomes more reminiscent of a reflex and seems unlikely to be enriching. It then no longer represents a learning opportunity.

Similarities have been demonstrated in the steps required to stimulate behaviour mediated by training or conventional environmental enrichment (Hare and Sevenich, 2001). It is clear however that there are many **qualitative differences** between these two strategies. Training provides less flexibility, control and an artificial contingency between cue and behaviour compared to the conventional environmental enrichment strategy which utilizes a naturally occurring contingency between cue and stimulus. Even if training cannot always be considered enriching by itself, it can achieve the **same outcomes** as environmental enrichment and through their consequences, both may **improve animal welfare.**

**Types of training : Positive and Negative reinforcement**

Two kinds of trainings exist and are often combined in zoo training programs : positive and negative reinforcement training. They should be used with caution, as they can promote but also compromise animals welfare as studied on dogs and horses training (Hiby et al., 2004, McGreevy and McLean, 2009).

Zoos have adopted positive reinforcement training, to reinforce the likelihood of a target behaviour being performed in the future with the most common example being offering food after expression of a desirable behaviour (Grandin et al., 1995).

Less commonly, negative reinforcement training is used, especially in work free contact, without any barriers between keepers and animals, hoping to reach the same result. For example, punishing animals by ignoring them can increase targeted behaviours (Roberts et al., 1988). The use of negative reinforcement has been well documented in horse riding, being the basis of horses' training, with pressure via reins, whip or legs and heels to change horse's movement (Innes and McBride, 2008, McLean, 2005, Warren-Smith and McGreevy, 2007)

Suppressing aggressive behaviour from one individual to another can also be achieved with training incorporating reinforcement. Immediately reinforcing the aggressor for the behaviour you want to see, teaches the aggressor to accept the rest of the group.

“It was through the handling of two performing male sea lions that the first author discovered a technique for reducing aggression and enhancing positive social interaction that is referred to as cooperative feeding” (Laule & Desmond, 1991)

In the practice, this entails reinforcing two events within the group simultaneously: Dominant animals are reinforced for allowing subdominant animals to receive food or attention, whereas the subdominant animals are reinforced for being ‘brave’ enough to accept food or attention in the presence of the dominant ones. In case a new animal is introduced into a group, this technique can be efficient to ease territoriality and aggression, and therefore improve quality of life. Studies have shown significantly reduction of excessive aggression (Bloomsmith et al., 1994) and an increase in affiliative behaviours as a result of training (Cox, 1987; Desmond et al., 1987; Schapiro et al., 2001; Schapiro et al., 2003).

**Medical training**

Interactions with both keepers and veterinary staff for routine husbandry activities and medical care can be stressful and frustrating. But while these interactions are a health necessity, medical training can help reduce that stress in encouraging bonding between animals and keepers (and veterinarians). As a result, animals are trained by zoo keepers to voluntarily cooperate and accept unnatural processes, and procedures. This allows physical or chemical restraint, having their dangers, to be avoided in various situations. This facilitate management and husbandry routines, ease inspection and treatment by veterinarians and maximize safety for both humans and animals. This goal oriented training uses positive reinforcement with manipulation of targets mainly but shapes and colours too.

“They participate because it’s a fun game they have been taught to play,” says Ken Ramirez. “If you teach a tiger to come into an enclosure for a medical exam, when they come into the enclosure you might give them a big slab of meat or a toy they like to play with — something that makes it worthwhile for them to participate.”

On a regular basis, veterinarians might need to isolate, examine and manipulate captive animals in several potential situations in which animals will learn to cooperate willingly : clinical examination, tooth brushing, hoof trimming, injections such as medications or annual vaccinations, and blood draws, for preventive care or in case of emergency because of an illness or injury.

**Example of white rhinos training**

White rhinos commonly have foot problems like nail cracks and laminitis, skin problems, parasites, bacterial or viral infections and reproductive disorders. Due to medical training, white rhinos can easily be examined with the least stress and highest safety levels for the keepers and vets (Goltenboth et al., 2001).

Some common commands and behaviours, according to AZA, used for white rhinos :

- **Target** – command used for positioning. The rhino should touch the target with its upper lip while the target is placed at the location where the trainer wants the rhino positioned.


*Figure 29 & 30 – „Target" command*

- **Steady**: Command given to have the animal hold in the desired position for a certain amount of time (i.e. if the rhino's foot is on a block, when drawing blood,etc.)

- **Over or Lean in:** For lateral positioning, allowing blood draws or evaluation of the condition of the rhino. the trainer uses the command "target" to line the animal up, and then holds the target to the animal's hip or shoulder. Then, when the "over" command is given, the animal should then side step towards the target and basically move the entire body closer to the wall of the chute.


*Figure 31 & 32 – „Over" or „Lean in" command on the back side and front shoulder*

- **Open** - for checking the mouth for gum coloration, presence of lesions or sores, or general dentition inspection. The trainer first targets the animal's head into proper position, and then issues the command "open".


*Figure 33 & 34 – „Open" command and mouth examination*

- **Foot**: used for positioning desired leg for phlebotomy procedure or to perform any necessary footwork. The trainer give the command "foot" to signal lifting of foot onto the block and placing it flat on the surface. Then he places a hand on top of the foot while saying, "steady".


*Figure 35 & 36 – „Foot" signal - foot onto a block, then phlebotomy respectively*

- **Down** : to make the rhino lie down in a sternal position parallel to the bars. The trainer uses the command "over", and then use a physical cue such as rubbing the rhino's back or the inside of the back legs to encourage them to lie down


*Figure 37 & 38 – „Down" command – Rubbing the rhino's back and trainer with rhino in sternal position respectively*

- **Back**: Command given to the have the animal step backwards, either for positioning or exiting the chute.

- **Move Up**: Command given to have the rhino step forward for positioning, can also be used to enter/exit the chute.

- **Ear**: Command given to relax the ear to draw blood.

- **Tail**: Command given to relax the tail, which allows the trainer the ability to manipulate the tail in the desired position, either for blood draws, or rectal ultrasound/palpations.

It should be noted that keepers usually try to use the same cues internationally, to make sure that training will be smoothly continued in case of an animal being relocated in a new facility.

Environmental Enrichment is widespread, and has been utilized and studied on all types of animals including exotics but farm, laboratory and companion animals too (De Azevedo et al., 2007). In contrast, the use of training to facilitate husbandry and veterinary needs, has increased rapidly in the past decade, but few studies about the impact of training on behaviour and welfare exist. Without a systematic empirical approach it is difficult to fully appreciate the costs or benefits associated with training zoo animals and further research is needed in this area. (Melfi, 2013)

## 2. How can enrichments can be effective ?

To make science-based and ethical decisions in favour of the animals and combat for the reduction or absence of stereotypic behaviour, it is essential to understand the animals under our care, what their needs are, and what motivates them. A “one size fits all” approach to enrichment is not credible, given that individuals have different levels of skills, motivation, needs. By assessing their behaviours the right enrichment can be targeted. Enrichment programs should be adapted and point at individuals and species-appropriate behaviours according to the natural behaviours and needs previously discussed.

### 3.1. Individual appropriate

It is important to observe the animals which will be targeted by the enrichment, to propose an adapted program as they all have different body measurements, weight, physical ability, strength, etc. All of those factors need to be taken into consideration to make it safe and elicit wellbeing. Moreover, individuals have different personalities and can be motivated by different stimuli. The use of objects to enrich animal environments should not be considered to be effective until its success has been scientifically demonstrated.

Fabienne Delfour and Helen Beyer investigated the use of 21 familiar objects with a group of bottlenose dolphins (Tursiops truncatus). The dolphin trainers introduced different objects into the dolphin pool every day on a rotating basis. The results revealed a positive correlation between interest behaviors and interactive behaviors. But some dolphins elicited manipulative behaviours on only 50% of objects and had “favorite toys”. Not all toys could be considered enriching, rather the motivation for the dolphins' behaviors toward the objects was investigated.

### 3.2. Species-appropriate

The identification and provision of the appropriate stimuli necessary for the physiological and psychological well-being of a wide range of captive species is the main key to establish useful environmental enrichment (Shepherdson, 1998). As discussed previously, each species has specific natural behaviours and needs. Indeed, learning opportunities must be tailored to a species specific need (Swaisgood 2007; Griffin 2012). For example, creating lots of opportunities for social interactions for an asocial species like cheetahs would clearly be

inappropriate even though it may create many learning opportunities and might be more damaging than improving wellbeing. On the contrary, some species like lions need social interactions with their conspecifics and would benefit from it. Then, giraffes are herbivores whose digestive system require to be active all day long. Therefore, they need to search and eat great amount of forages with low nutritional value most of the day. On the other hand, felids hunting and feeding on high calorie food, spend a lot of time resting and searching food. The size of the exhibit and feeding system needs to be adapted accordingly. In addition, domestic cats have shown to be more interested in and responsive to music that was composed with species-appropriate features relevant to cats. Auditory enrichment must be appropriate for the species, by containing features perceptible to the targeted species, and adapted to the enrichment goals. More simply, in order for music to be effective, it must be in the frequency range and with similar tempos to the natural communication of each species (Snowdon et all, 2015). Moreover, if we have a look at Apes, who are highly intelligent, we can observe they have a high behavioural need for cognitive challenges, are easily bored, and quickly show abnormal behaviours compared to most other species. So species-appropriate enrichment will have a greater impact on animal welfare as it can stimulate species-specific behaviours.

### 3.3. Challenges

Animals living in the wild have to face many challenges including of predation, social competition or finding a partner to produce offspring, weather conditions, food and water availability, and illness. On the contrary, animals in captivity often live in an environment which is simple, predictable and monotonous. Challenges are limited, infrequently or not present at all. Appropriate challenges need to be offered by enrichment and mostly match animals' sensory, physical and cognitive capacities. Adjusting to the potential abilities of the animal and its current level of skills will prevent boredom, and at its opposite end, fear, anxiety and stress. Gradually transitioning from under-stimulated to full-stimulated environments may be necessary initially too.

*Figure 39 – Hyena unable to access its food enrichment (pole feeding) due to lack of motivation and skills*
*(https://www.zoosnippets.com/static/img/hyena_challenge_too_complicated.jpg)*

Challenges create opportunities to express agency and develop competence by engaging with their environment in a proactive way. Developing skills make them competent to be resourceful and skilful in a species-appropriate way to deal with future events.

Challenges are suggested to be rewarding and enjoyed by the animal in a certain length, like the concept of contrafreeloading. This intrinsic motivation to engage goes beyond its momentary and basic needs.

The interaction between perceived challenge and skills, which Moneta and Csikszentmihalyi (1996) labelled as 'flow', chase each other. If the level of challenge is higher than the level of skill, it will try to learn new skills. If skills are higher than the challenge, the animal will seek more challenge.

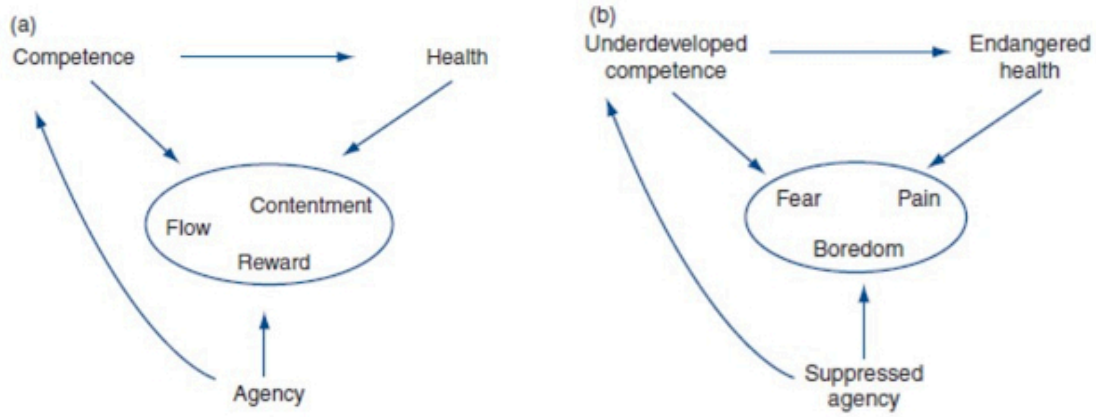


*Figure 40 – Difference between challenges provided or not in relation to animal welfare (Špinka and Wemelsfelder, 2011)*

### 3.4. Wrong Enrichment

If an abnormal behaviour appears, it is important to notify what is the actual environment and when/in which condition does it occur to be able to respond and solve the issue at its root. Many times, the unwanted behaviour is blocked (e.g. block the route of locomotor stereotypes) or environmental enrichment which won't respond to the cause of the undesired behaviour is provided.

For example, a tiger has recently started to pace in his enclosure.

Option 1 : You can block the route it repetitively walks, but this will often result in walking another repetitive path or result in frustration. The initial behaviour might disappear but without solving the cause of problem.

Option 2 : Another way to respond to this unwanted behaviour is to add additional enrichment to provide stimulation and alleviate boredom.
If caused by boredom, it can effectively reduce this undesired behaviour. But if pacing started because of ambient noise, a new inhabitant, the onset of the breeding season, increased crowd size, or a combination of these for example, the enrichment effort may not result in reducing this behaviour. The underlying concern that drives the stereotypic behaviour won't be alleviated.

### 3.5. Prevention comes first

However, in many zoos enrichment is implemented when animal welfare problem appears. Stereotypies may not even reflect the current condition but remain of past experiences. Once stereotypic behaviours have been established and become a habit, they become (almost) irreversible. Stereotypes are a coping mechanism for the environmental stressor, and it is self-reinforcing, which cause its perseverance. It is advised to apply enrichment to prevent abnormal behaviours before they become a habit. As we can say, it is easier to prevent it than to cure it.

### 3.6. Different Aims – Goal behaviours

In captivity, absence of stress and abnormal behaviours are by themselves insufficient criteria to ensure animal well-being. They need to carry out highly motivated behaviours, in particular those supporting the goals of the program for which they were raised. Therefore, enrichment needs to be adapted and will depend on the purpose the animals are kept for.

Good welfare also promotes more ecologically valid research findings on healthy animals (Buchanan-Smith et al., 2001). Therefore, promoting good animal welfare is fundamental not only for the individual animal, but also to achieve high standards in successful conservation, rehabilitation, reintroduction, research, captive breeding, education, and entertainment programs. Goal behaviours depend on it.

### 3.7. 24/7 across lifespan

Few problems subsist : the economical aspect but more importantly the time demands on caretakers, who have many tasks to accomplish during the day, I can't dedicate all their time to the animals. Husbandry activities are often scheduled for the convenience of care staff working within the constraints of the facility, rather than considering the biological and psychological requirements of the animals living all day and nights in captivity. The 24/7 across lifespan framework, illustrates the different aspects that should be considered and integrated (figure 41). It is also influenced by the season as zoos have different opening hours accordingly, represented by figure 42 :

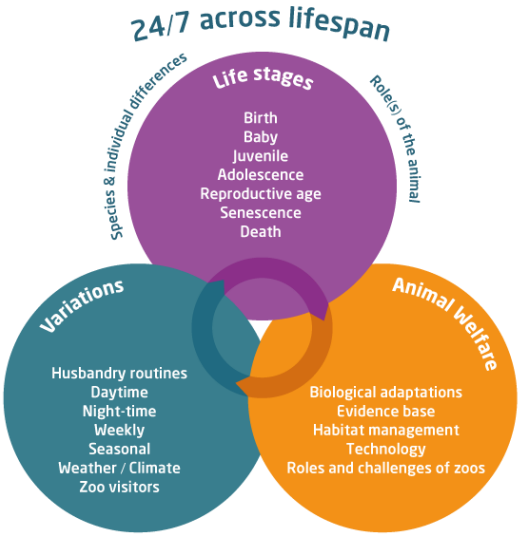


*Figure 41 – 24/7 across lifespan framework*

(https://animalconcepts.eu/247animalwelfare/index.html)

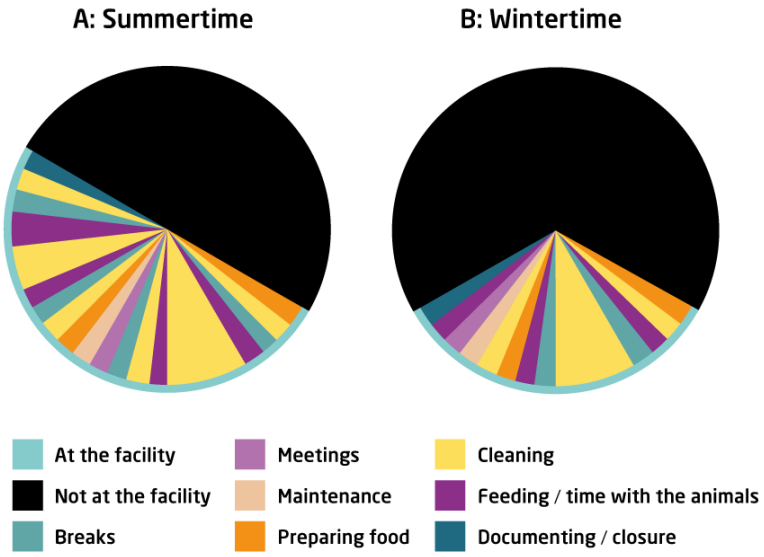


*Figure 42 – Example of an average (A) summer and (B) winter day considering different activities and time with the animals (personal observations based on 25 years of practical experiences in zoos) (Brando et al, 2018)*

### 3.8. Enrichment plan : Frequency, variety, variation, rotation against boredom

To create the most adapted and diverse enrichment programs, it is advised to create an enrichment plan, especially in large infrastructures hosting many animals. This way frequency and variation of the different enrichments can be easily implemented on a rotation basis and its results can be tracked. Many systems exists and here is an example of rotation and tracking strategy (figure 43).

**ENRICHMENT TRACKING**

| Enrichment | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SATERDAY | SUNDAY |
|---|---|---|---|---|---|---|---|
| Type for day >> | Food | Object/structural | Olfactory | Food | Object/structural | Cognitive | Olfactory |
| PROVIDED | | | | | | | |
| EVALUATION | | | | | | | |

| Enrichment | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SATERDAY | SUNDAY |
|---|---|---|---|---|---|---|---|
| Type for day >> | Food | Object/structural | Olfactory | Food | Object/structural | Cognitive | Olfactory |
| PROVIDED | | | | | | | |
| EVALUATION | | | | | | | |

*Figure 43 – Enrichment tracking document (ZooSnippets 2020)*

To set up and maintain a well-thought animal behavioural enrichment, the S.P.I.D.E.R framework (figure 44) has been created and used by animal care staff since 1998. Also helpful in animal training programs, it helps set up, review, refine and modify environmental enrichment programs to find the program that would best fit animals. This process is even a requirement of AZA enrichment and training programmes.

**S – Setting goals** : Learning natural and individual history of the species and identifying the unwanted behaviours and the goal behaviour

**P – Planning** : Creating an enrichment plan

**I – Implementing** : scheduling and executing the enrichment initiative

**D – Documenting :** Animal care staff record Video, photos, written logs, and computerized tracking programs to observe the initiatives and trends

**E – Evaluating :** essential step of observations, meetings, conversations, and individual evaluation (Many times, the enrichment initiative may be utilized by the animals differently than the original intent which needs to be evaluated)

**R – Readjustment :** happens throughout the process, before providing enrichment, after evaluation of documentation, and even in the process of setting goals.

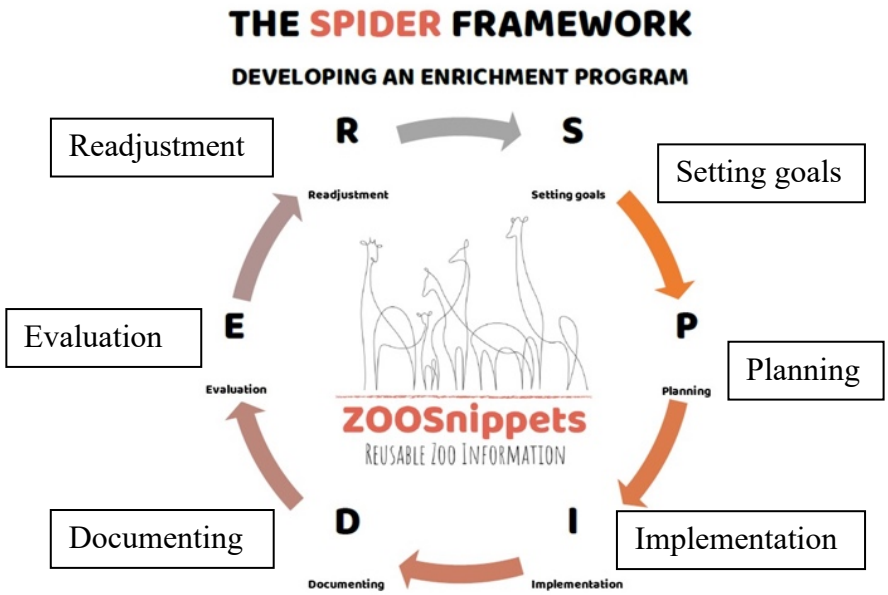


*Figure 44 – SPIDER framework (ZooSnippets*

### 3.9. Safety : Enrichment gone wrong, needs to be adapted

It is very important that enrichment is adapted to the species and individuals to keep them safe and have a positive impact. Cage-mate, whether the intended user of an enrichment item or not, also has to be considered as they will also have access to it and greatly vary in size from the intended animal. Their maintenance is also essential as they can be modified, disassembled or broken by animals interactions with them and create dangerous situations.
Sometimes enrichment doesn't work or works too well and doesn't lead to the expected behaviour. To enrich some African lions *(Panthera leo)*, burlap also called hessian fabric was hung from two trees in the enclosure. One was a sack containing leaves suspended on bungee cord and the other a hanging strip. Scents, brushes, and piles of branches, dirt, and camel wool were also placed in the enclosure. The lions were intrigued by these novel items and have been observed biting and pulling on them throughout the day. It held their interest so much that lions would not enter their night quarters until late the following day.

Accidents can also happen and enrichment can become very dangerous, sometimes even lethal. Objects used in environmental enrichment should not cause distress and aggression, be toxic or irritating for animals, and cause injuries. Animal hazards include ingestion, entanglement, suffocation, entrapment of body parts, tooth damage or impaction, and so on.
In December 2018, Keepers at Edinburgh Zoo had to call the Scottish Fire and Rescue Service after their juvenile male rhino, had its head and leg stuck through a tyre, which was used as enrichment. The one horned rhino loved to play with it and it was not the first time he had got himself stuck, but he usually managed to get himself out. This time the rhino had to be sedated and the firefighters had to use specialist cutting equipment usually used for road traffic collisions to free him. Luckily the rhino was saved.

*Figure 45 - Firefighters attempting to free a rhino stuck in a tyre (Edinburgh News, 2018)*

Enrichment should be encouraged but taking into account safety hazards. When designing enrichment, material and hole sizes need to be considered. Holes must be either too large, so inserted body parts cannot become stuck, or too small to prevent insertion of body parts. Body measurements, taken during routine medical examinations thanks to medical training, can be helpful when determining appropriate sizes.

## 3. Example of a potential enrichment plan for lions

As explained earlier, there are five elements for a successful enrichment programn confirmed by Wild Enrichment. The enrichment plan needs to take into consideration the animal's history, include some challenge, provide novelty and should be based on scientific studies, to best fit the species and individuals' needs. By understanding of an animal's natural history species-specific enrichment opportunities can be created and result in the display of natural behaviours. Continuous challenging scenarios should be presented to animals to mimic challenges they would face in the wild. Variation & Variety is essential to keep an item challenging and enriching. Novelty like completely new enrichment items, is needed and vary according to species. The key to success is to keep track of specific enrichment goals and its success to continuously readjust enrichment programs over time. Materials type and resistance, holes size, and toxic products should be paid attention to, to provide a safe enrichment and avoid any complication. It should be reminded that enrichments are non-exclusive and can involve several categories.

In this chapter, we won't go into details, and won't go through the whole process. Here is an overview about how creating and implementing a potential lion enrichment program works :

- Observation & Problem recognition: One male and three female lions are kept together in an enclosure, all showing high amount of pacing, very low daily activity, and they are always staying in the same area of the enclosure.
- Goal-setting : Decrease stereotypies and inactivity, increase natural species-specific behaviours (exploratory, hunting, etc.), increase activity daily time budget.
- Planning and approval process
- Implementation
- Documentation/record-keeping
- Evaluation
- Program refinement

| **Enrichment tracking** *(Figure 46, part 1)* | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Type of enrichment** | **Structural** | **Nutritional** | **Cognitive** | **Structural** | **Social** | **Nutritional** | **Sensory** |
| **Date** | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |
| **Enrichment** | Hang items with ropes | Pole feeding | Piñata with novel item with or without scent (feathers, wool, fur, snake sheds, substrate with urine deer, etc.) | Cardboard boxes | Training | Ice blocks containing fish | Jute bags with scent (used as bedding at the goats exhibit, with catnip, lavender etc.) |
| **Evaluation** | | | | | | | |
| **Date** | Day 8 | Day 9 | Day 10 | Day 11 | Day 12 | Day 13 | Day 14 |
| **Enrichment** | Wood piece | Whole carcass | New item : Ball, rope, barrel, toy | Shelter with branches | Substrate with feces, urine, or glandular secretions from conspecifics | Swing pole feeder | Giant wind chimes |
| **Evaluation** | | | | | | | |

| **Enrichment tracking** *(Figure 46, part 2)* | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Type of enrichment** | **Structural** | **Nutritional** | **Cognitive** | **Structural** | **Social** | **Nutritional** | **Sensory** |
| **Date** | Day 15 | Day 16 | Day 17 | Day 18 | Day 19 | Day 20 | Day 21 |
| **Enrichment** | Non-toxic plants | Live fish | Paper bag | Scratching brush | Training | Hanging Holey Log (wood with holes filed with meat bits) | Mirror |
| **Evaluation** | | | | | | | |
| **Date** | Day 22 | Day 23 | Day 24 | Day 25 | Day 26 | Day 27 | Day 28 |
| **Enrichment** | Water pool | Scattered feeding (places on branches, suspended on strings, hidden within branches or on the ground | Spinning PVC Puzzle filled with meat | Movable perches with different levels | Plush toy | Whole carcass | Tree trunk covered with prey scent |
| **Evaluation** | | | | | | | |

## Conclusion

Over the last decades, much progress has been made in understanding animal welfare. Today, around 1 million vertebrate animals live in captivity worldwide while ethical concerns have been rising, along with the modernisation of zoos. Used to entertain the public, they are now the key for conservation programs and education of the public in a world in which endangered animals are quickly disappearing. We realize there is much more to be done in terms of understanding different species' behaviour and how we can impact their wellbeing negatively and positively.

The issue of animal welfare in captivity is complex, has a multidimensional nature and can be approached from different angles. Various tools are at our disposal such as, physiological, psychological, pathological, biochemical and behavioural measures, the latest being the one we focused on in this thesis. They help us have a better understanding of animals' welfare, dependent on individuals personality, species, sex, lifestage, background and reproductive condition. By understanding animals' natural behaviours, abnormal and stereotypic behaviours can be noticed, and their issue addressed. By setting up various environmental enrichment such as physical habitat, nutritional, sensory, cognitive and social enrichment, stereotypic behaviours can be massively reduced, and even prevented. But establishing an enrichment program is complex and should be created to be varied, safe, adapted, reviewed, and readjusted to tackle the right issue and greatly improve animal welfare.

In the EU especially, animals in captivity are protected by legislations. But in many zoos around the world, the curtain is rising on the conditions in which animals are living, far from fulfilling their needs and from reaching animal welfare standards. A high number of countries do not have the legislations to protect them, and the knowledge and funds to understand their behaviours and provide the necessary environment.

These concerns raises more questions on how can legislations evolve, what are the best strategies to protect wildlife, provide education and awareness, and reach high standards to protect all the animals who will spend their life in captivity.

**Abstract**

Through history animals have lived under human care for various purposes. Their role, position and rights in our society has constantly been evolving as well as the purpose of their captivity. We have studied them for many years before recognizing them as sentient being with needs, who are capable of positive and negative feelings. But respecting animal welfare is an ethical issue raising concerns today. From entertaining menageries to modern zoos, they nowadays have a new duty in raising awareness and conservation programs for endangered species.

In this thesis we first briefly review what Animal Welfare signifies and how we can assess it legitimately in the heart of biological science. After understanding this complex and multidimensional subject involving scientific, ethical, economic, cultural, social, religious and political aspects, we focus on its relationship with behavioural science. A closer look on natural and stereotypic behaviours in different species opens a discussion on how can we provide diverse natural behaviours and good welfare in captivity. Exploring adapted and safe environmental enrichment such as physical habitat, nutritional, sensory, cognitive and social enrichment, we highlight their benefits and how to influence efficiently stereotypic behaviours and wellbeing. Finally an enrichment program for lions in captivity is proposed, showing the critical points which need to be addressed to satisfy both the public, keepers and welfarists' concerns and demands.

## Összefoglalás

A háziasítás megindulása óta az emberiség számos állatfajt tartott számos különféle célból. Életünkben betöltött szerepük, helyzetük és "jogaik" folyamatosan változtak és fejlődtek. Hosszú évekig tanulmányoztuk őket, mire felismertük, hogy tudattal bíró lények, melyek képesek mind pozitív, mind negatív érzésekre, és ha szükségleteik nem megfelelően vannak kielégítve, szenvedni képesek. Az állatjóllét és annak tisztelete napjainkban is sokat vitatott és finomított etikai kérdés.

Az állatkertek történetük kezdete óta sokat változtak, az első, kizárólag az emberek szórakoztatására megépülő menazsériáktól eljutottunk a modern intézményekig, melyeknek komoly szerepe van az ismeretterjesztésben és a veszélyeztetett állatfajok megmentésében.

Jelen dolgozat célja az állatjóllét fogalmának, és annak tisztázása, hogyan illeszthetjük azt be a biológiai tudományok sorába. Miután megértettük ezt a komplex és többdimenziós fogalmat, mely magába foglal tudományos, etikai, gazdasági, kulturális, szociális, vallási és politikai aspektusokat is, megvizsgáljuk a viselkedéstudományokkal való kapcsolatát. A természetes és sztereotíp viselkedések áttekintése lehetőséget ad arra, hogy megvitassuk, hogyan lehetséges fogságban biztosítani, hogy az állatok változatos természetes viselkedéselemeiket kiélhessék, és hogy az állatjóllét megfelelő szinten megvalósuljon.

Áttekintjük a biztonsággal alkalmazható különféle környezetgazdagítási technikákat, többek között a fizikai, a takarmányozást érintő, a szenzoros, a kognitív és a szociális környezetgazdagítást. Rávilágítunk az előnyeikre, és hogy milyen módon befolyásolják a sztereotíp viselkedések megjelenését és a jóllétet.

Végül bemutatásra kerül egy fogságban tartott oroszlánok esetén alkalmazható környezetgazdagítási program, külön kiemelve azokat a kritikus pontokat, melyekre különös figyelmet kell fordítani, hogy mind a publikum, mind az állatgondozók, mind az állatjólléttel foglalkozó szakemberek aggályait és igényeit figyelembe vegyük.

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Finally, I would like to dedicate this work to all the animals who make our planet and life so colourful, and to the many living in captivity, because they deserve wellness.

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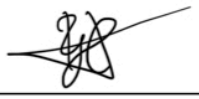

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