

Environmental Enrichment and Its Effect on the Welfare of Two Asian Elephants in Africam Safari Wildlife Conservation Park (Puebla, Mexico)

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Abstract

Animal welfare is important in zoos to maintain the physical well-being and psychological health of individuals. An animal is considered to have welfare if it has good nutrition and also expresses its innate behavior, including sensations and feelings experienced as a result of physical health. The objective of this study was to evaluate the effect of environmental enrichment on the behaviors of two Asian elephants in a wildlife conservation park. The behavior of two Asian elephants, a 46-year-old male and a 59-year-old female, was observed. Behavior was measured by quantifying the frequency, latency, and duration of behavioral actions. Measurements were done with *ad libitum* sampling during 5 days of testing, then observations were recorded with focal sampling for 25 days with environmental enrichment and 25 days without enrichment. Data were analyzed with the Chi-square statistical test using the statistical program SPSS 20, observing significant differences ($P < 0.0001$) in the type of behavioral actions with and without the application of environmental enrichment. The frequency of maintenance behaviors was higher when environmental enrichment was provided, and the frequency of social conducts (affiliative and agonistic) decreased. In fact, the behaviors most frequently presented by elephants with and without environmental enrichment were definitely maintenance behaviors. The environmental enrichment program helped to reduce the duration of abnormal behaviors and increase the frequency of typical behaviors of the species. It also increased independent movements within the exhibition area and helped to know each of the elephants individually in order to apply each enrichment combination according to their needs.

Keywords

Asian Elephant, Animal Welfare, Environmental Enrichment, Behavior

1. Introduction

The well-being of individuals is the state regarding their attempts to face the environment in which they live [1]. One of the most important objectives of zoos is to maintain both the physical well-being and psychological health of animals. Sudden changes in the animal environment or improper handling practices can be stressful. Stress is defined as a variety of responses to external or internal stimuli that can modify the homeostasis of individuals [2] [3] [4]. Stress factors are divided into social (isolation, disturbed social order, introduction of animals to a new group and crowding), physiological (hunger, thirst, and dietary changes), physical (injury and fatigue), pathology (diseases and pain) environment (heat and cold) and management (fear) [5] [6]. However, living beings develop physiological systems to be able to buffer adverse environmental conditions and re-establish homeostasis [2].

It is considered that an animal is in a state of optimal welfare if it is healthy, has good nutrition and comfort, is safe, and able to express its innate behavior including sensations and feelings as a result of physical health. It is also important that animals do not experience unwanted states such as pain, fear or anguish; but they face more positive experiences than negative ones. Always considering that animals have the ability to face critical negative experiences of survival on their own. It is worth mentioning that animal welfare can vary from very poor (negative) to very good (positive). Overall, the state shall be considered poor, neutral or positive according to the type of experience that predominates, or if those experiences are in balance [7].

The Five Freedoms of Animal Welfare were published in 1965 to describe the right to the welfare of animals under human control. These good practices are a kind of declaration that animals must be 1) free from hunger, thirst and malnutrition; 2) free from fear and anguish; 3) free from physical or thermal discomfort; 4) free from pain, injury or disease; and finally, 5) free to express their innate patterns of behavior [8].

Environmental enrichment, also known as behavioral enrichment or simply referred to as enrichment, is a husbandry principle that seeks to enhance the welfare of animals in captivity by improving animal's mental well-being and/or physical fitness. Although the concept of environmental enrichment has usually been associated with objects animals that can "play" with, environmental enrichment goes far beyond the random addition of items into a facility. Enrichment is a goal-directed and pre-established strategy to enhance animal welfare by promoting positive emotional and physical states. These states are achieved through stimulating natural rewarding behaviors, and through covering other needs that could

not be fully fulfilled under animals' specific structural living conditions (management routines, facility design, social context, etc.) [9].

Environmental enrichment is a stimulation technique used to improve the care of captive animals considering their biology and natural behavior in the wild. Environmental enrichment has become an integral part of the daily functioning and management of animals in zoos as it is a tool that ensures animal well-being. As a result of environmental enrichment, reproduction rates are increased, and both stress and its manifestations are reduced. In addition, stimulation increases the typical behavior of the species and helps to reduce stereotypies [10].

Captive animals are in an environment totally altered by man, in which organization and control are regulated by human beings, making the animals unable to manage their habitat and resources; all of which play a fundamental role in stress levels and animal welfare [2]. Over the past few decades, concern for the physical well-being and psychological health of zoo animals has become more prevalent in the zoological profession. A forefront example of this issue is the welfare of elephants. Zoo elephants, in particular, have been the subject of numerous debates on welfare, especially related to foot health, gait and stereotyped behavior.

However, only a few scientific studies have comprehensively focused on the activity and behavioral health of elephants in captivity. In a zoo environment, elephants are not under pressure to forage for food or water and are instead more prone to obesity due to the high quality of food and the addition of fortifying foods. Therefore, zoo elephant management should consider the occupational needs of the animals [11].

There are many reasons why zoological institutions should be encouraged to implement environmental enrichment programs, which foster an environment in which zoo animals develop behaviors typical of their species. It is a dynamic process in which changes in structures and management practices are made with the aim of increasing the behavioral options available to animals that promote the appropriate behaviors and skills for their species thus improving their welfare [12].

Therefore, an environmental enrichment program was planned for the elephant herd of a Mexican Management Unit for Wildlife Conservation (UMA) and the effect of environmental enrichment was evaluated on the behaviors of two specimens of Asian elephants (*Elephas maximus indicus*) on the common exhibition area; animals living together were evaluated in pairs and individually in the exhibition area of the Asian elephants at Valsequillo, Puebla (Mexico).

2. Material and Methods

2.1. Location of the Study Area

The city of Puebla is located at coordinates 19°02'38"N and 98°11'51"W at 2137 m above sea level, with an average temperature of 16.4°C and rainfall of 1032 mm per year; rains occur in summer from June to October [13].

The study was established in the Wildlife Conservation Park “Africam Safari” which is registered in Mexico as an UMA, with registration number INE/CITES/DFYFS/ZOO/P/003-00PUE is located on Blvd. “Captain Carlos Camacho Espíritu 17302, Int. 22; Carretera al Oasis km 16.5, Colonia Africam” Puebla (Mexico). This park houses animals from all continents of the world that range freely in huge open spaces. This UMA occupies an area next to Lake Valsequillo. The area of Asian elephants is characterized by an ecosystem resembling that of their natural habitat.

2.2. Description of the Elephant Accommodation

The elephant section has an exhibition area (**Figure 1**) with the floor covered with red gravel (in Mexico known as *tepetate*), and reinforced wooden poles joined with an electric fence that surrounds the entire exhibition area, with a minimum of 8 kilovolts and a maximum of 15 kilovolts. The area has two metal doors, one for entrance from or exit to the outside, and another one that communicates the exhibition floor with the three rooms where elephants spend the night. There are drinkers, feeders, and inside light which are used occasionally. The elephants sleep in separate rooms one night and are rotated daily to sleep the next night in a shared room with the door open to grant access to the playground and exhibition floor at night.

The facilities have a system of hydraulic doors that have an approximate weight of 0.8 to 1 ton. With this system, doors can be easily manipulated with electric levers for greater safety of elephants and keepers and can also be operated from the outside. All doors have open/close locks that also can be manipulated from the outside. Likewise, those locks are finally secured with large padlocks suitable to avoid being moved by the specimens.



Figure 1. The exhibition area for Asian elephants.

2.3. Description of Elephants

The behavior of two Asian elephants (*Elephas maximus indicus*) was studied, one male and one female. The female elephant's full name is Honey Ball, and she is called Honey (**Figure 2**), was born in 1960. She entered the Zoo of Leon (state of Guanajuato, Mexico) in 1997; and later worked at Bell Circus where she injured several people and killed two of her trainers. In the Zoo of Leon, she shared an exhibition area with a pair of African elephants, from which she was separated by aggression from the male. She was not retrained or managed because of her history of aggression and lack of adequate facilities to do so. On May 16, 2006, she arrived at Africam Safari and on June 6 the period of coupling with her partner (Ship) was successfully ended, without presenting any type of aggression between them; they were together day and night. After Ramus arrives, India (another female) sleeps apart, while Honey sleeps with Ramus and they share one exhibition floor during the day.

Honey weighs 3744 kg and measures 3.10 m in length and 2.4 m in height. She responds positively to training sessions. She is sociable with Ramus and has no problem sleeping apart from him. She is extremely curious and quick to solve new problems. It is extremely aggressive, very fast and hits hard. The training is done with protected touch. She learns with great speed and does not like to be touched in various body areas. Sometimes she refuses to cooperate, and training is interrupted. She is barely tolerant of coaches; one has to be careful with her because she does not trust new coaches quickly. Due to the training program, she is accustomed to the presence of new people. However, overconfidence is not convenient. In new situations, she is curious but also nervous. For disciplinary correction only temporary or definitive time-out is used; this occurs basically when Honey demonstrates some kind of aggression against the trainer or any other person.



Figure 2. Female elephant: Honey Ball.

The male is called Ramus (**Figure 3**) and was born in 1973. He used to work in a circus where he hurt several trainers, after that he spent a long time at the Zacango Zoo without receiving any training sessions. He arrived in Africa on October 16, 2007, and then in a few days successfully coupled with the females Ship and Honey. He spent several months together with the females, later it was decided to separate him from Ship due to the condition she presented. Ramus lives very well with Honey and for now, they share the exhibition floor separated from India, another female who arrived in Africa on January 25, 2009. Ramus was continually aggressive towards India, so she was afraid of him. Nowadays, Ramus sleeps alone one night and sleeps with Honey the next.

This male elephant weighs 5271 kg and measures 3.65 m in length and 2.4 m in height. His temperament is very dominant. He acts calm most of the time, but usually throws objects or feces at caregivers. He lives with Honey. Since November he has shown more aggressive behavior due to the presence of the musth that lasts 4 months. The training is done with protected touch. Ramus learns with great speed and is easy to convince with prizes. He is more advanced in medical routines, sometimes interrupting training sessions to approach the door of her teammates Honey and India. But he almost always continues with the training because of the awards he receives. For disciplinary correction, only temporary or definitive time-out is used, which although it is a slow process, is proven to give good results. Correction is basically used when the elephant demonstrates some type of aggression against the trainer or any other person.

2.4. Measuring Behavioral Patterns

The behavior was measured by classifying behavioral actions and responses. Three basic units of measurement were used to quantify behavioral actions: frequency, the number of times a behavior occurs in an allotted period of time; latency, the time it takes for a behavior to occur and duration, the length of time the individual is observed performing a behavior.

The measurement was carried out with an *ad libitum* sampling during 5 days of testing, then observations were made with focal sampling for 25 days with environmental enrichment, and 25 days without enrichment. Times were measured with a stopwatch; they were recorded with an iPhone 6 rear 8 MP camera with video recording, and a field notebook to document the ethological record. This type of sampling involves measuring the behavior of an individual (or a couple, nursing herd or other type of unit) during a given period of time by recording the behavioral patterns they perform [14]. Those behaviors are described in detail and added to the ethogram of each of the individuals.

Observations were made from the ceiling of the rooms at night (**Figure 4**), this site is behind the exhibition area of Asian elephants from where the measurements of the behavior patterns could be made correctly. Because in front of the place, there are some trees and plants that keep observers out-of-sight of the elephants, not to be an influential factor in their behavior.



Figure 3. Male elephant: Ramus



Figure 4. Area from where the observations were made.

2.5. Elaboration of the Environmental Enrichment Options

Twenty-five options of enrichment were elaborated manually. The same enrichment was manufactured twice or more so that when applied each elephant had the opportunity to interact with the enrichment and avoid conflicts (**Figure 5**).

The enrichments were elaborated intending the elephant would develop rewarding natural behaviors, dynamic environments, and cognitive challenges. Dif-

ferent types of materials were used, provided by the Department of Animal Welfare in the Wildlife Conservation Park “Africam Safari”. Those materials were previously supervised by the same department to comply with safety measures; intending they were not toxic, did not act as a weapon; they were of a considerable size, and made of a suitable material. All these preventive measures depended on each individual, in the case of food fortification. The portions were used according to the diet provided daily by the Department of Animal Nutrition (Table 1).

Table 1. Name of the environmental enrichment, type and material for elaboration.

Name	Type	Material
Trap sacks Num 1	Nutritional, sensory and cognitive.	Jute, sisal rope, fruit, concentrate, oats, non-toxic paints.
Plastic jerry cans with fruit	Nutritional and cognitive	Plastic jerry cans with vegetable oil, jute, sisal rope, needle, drill, sandpaper, fruit.
Blankets with color and essence	Nutritional and sensory	Jute, sisal rope, essences, non-toxic paint and needles.
Ice popsicles Num 1	Nutritional and sensory	Bucket, water, edible coloring powder.
Buried bamboo	Nutritional and cognitive	Green bamboo, hand saw, fruit.
Rain sticks	Sensory and nutritional	Bamboo, seeds, hand saw, drill.
Pinatas	Cognitive, sensory and nutritional	Plastic jerry cans with vegetable oil, jute, sisal rope, non-toxic paint, food, drill, sandpaper.
Jute balls	Cognitive	Jute, sisal rope, needle, oats.
Ice popsicles Num 2	Sensory and nutritional	Bucket, water, fruit, grass.
Meatballs with fruits	Nutritional	Concentrate, oat straw, water, fruit.
Ice popsicles Num 3	Sensory and nutritional	Bucket, water, edible coloring powder, flavoring, bamboo.
Stuffed mini bamboo	Nutritional	Bamboo, fruit, corn leaf, concentrate.
Trap sacks Num 2	Nutritional, sensory and cognitive.	Jute, sisal rope, fruit, concentrate, oats.
Green paste	Sensory and nutritional	Peanut butter, concentrate, banana, edible coloring powder.
Closed plastic jerry cans	Cognitive, sensory and nutritional	Plastic jerry cans with vegetable oil, jute, sisal rope, non-toxic paint, oats, beet stalks, corn leaves, drill, sandpaper.
Wrapped bamboo	Nutritional	Bamboo, concentrate, reed leaves.
Recycling	Nutritional, cognitive and sensory	Jerry cans, sacks, rugs, essences, non-toxic paint.
Fruit on poles	Cognitive	Sisal rope, fruit.
Sandwich	Nutritional	Whole wheat bread, peanut butter, seeds.
Jute hammocks	Cognitive	Jute, sisal rope, oats, fruit.
Hanging plastic jerry cans	Cognitive	Jute-lined and painted plastic jerry cans.
Hanging bamboo	Cognitive	Bamboo, sisal rope, ladder, fruit, concentrate.
Hanging plastic barrels	Cognitive	Barrel, jute, sisal rope, food.
Pole lining	Cognitive and sensory	Jute, sisal rope, fruit.
Bread hanging on poles	Cognitive	Sisal rope, whole wheat bread.



Figure 5. Elaboration of environmental enrichments.

The enrichment sessions included releasing aromatic essences uncommon in their environment (rosemary, sandalwood, roses, cinnamon, mint, lemon, lavender), as well as different drawings of different shapes and colors in the various enrichments that were composed with jute (**Figure 6**).

Color was added in the ice popsicles that were presented in different ways; for example, colored without flavor; without color and without flavor, but with fruit and grass; colored with flavor and bamboo (**Figure 7**). Edible coloring powder was also added to the concentrate with which colored meatballs were made and distributed within the exhibition area.

Sounds were added too, that animals themselves could produce by waving rattles and rain sticks with seeds; rain sticks and textures with colors and essences stimulated the senses of elephants. The introduction of elements such as jute balls, barrels, plastic jerry cans and sacks with holes and prizes inside stimulated the elephants to work on a cognitive level.

Changes in the presentation of foods posed various challenges that individuals

worked to solve, such as fruit on poles (Figure 8). Because feed was supplied in different ways daily and always trying to bring a different and busy day as it would have been in their natural habitat trying to feed by themselves (getting food, facing difficulties, gait and browsing).



Figure 6. Enrichments made with jute.

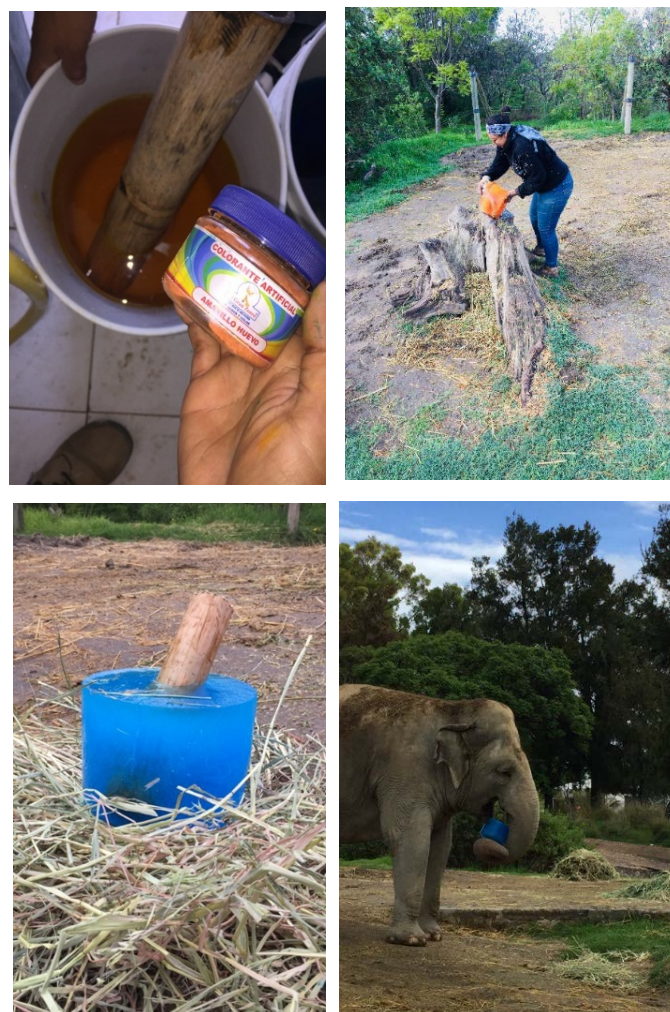


Figure 7. Elaboration and administration of ice popsicles.



Figure 8. Presentation of feed (fruit) on poles.

2.6. Application of Environmental Enrichment

Enrichments were applied in the mornings and afternoons always in the exhibition area. The time to apply them depended on the activities to be carried out in the day, and on the type of enrichment. Which could be thrown from the outside of the exhibition floor, such as trap sacks, plastic jerry cans, or rain sticks. In those cases when enrichments had to be hidden or hung, they were installed in the mornings before the elephants went out to the exhibition floor. The type of enrichment was applied depending on the materials that were obtained by the responsible Department; every day a different enrichment was applied.

An evaluation of the use of enrichment was done with the point sampling method. This type of sampling involves the measurement of individual behavior during a certain period of time by recording the behavioral patterns performed by one individual [14]. In this case, the activity was observed as enrichment for one hour per day per individual. Subsequently, catalogues of behaviors for each elephant were made, dividing them into motivational systems. Motivation is considered as the orientation toward a goal, which leads the animal to perform a behavior; this means motivation is an intermediate variable between stimulus and response [15].

2.7. Activity Log

Fifty ethograms were performed per elephant, out of which 25 ethograms recorded behaviors with enrichment, and 25 ethograms recorded behaviors without enrichment per elephant. Based on those, a catalog of behaviors with enrichment and a catalog of behaviors without enrichment were made separately for the two specimens *Elephas maximus indicus* evaluated. Presented behaviors were also recorded separating them by type, such as maintenance, affiliative, or agonistic.

2.8. Statistical Analysis

Data were analyzed with the Chi-square statistical test using the SPSS® 20 suite for Windows® [16].

3. Results

After analyzing the behavior of the two individuals *Elephas maximus indicus*, 35 different behaviors were quantified. Twenty-two were considered as maintenance (eating, sand bath, mud bath, gait, search, standing, self-grooming, swinging proboscis (trunk), exploring, sniffs, thermoregulation, food transport, trunk twists, rests, plays, urine, trumpeting, defecates, drinks water, wobble, geophagy, trunk biting). Nine behaviors were considered affiliative (sharing food, following their partner, walking/inspecting together, caressing, binding trunks, all grooming, waiting for their partner); and four behaviors were considered agonistic (wide-open ears, trunk fights, struggle, pushing). Statistically significant differences ($P < 0.0001$) were observed in the type of behavior depending on the application or not of environmental enrichment. The frequency of maintenance behaviors was higher when environmental enrichment was provided; the frequency of social behaviors (affiliative and agonistic) decreased. Consequently, the behaviors most frequently presented by elephants with and without enrichments were those of maintenance (Figure 9).

The application of environmental enrichment did not encourage elephants to exhibit a specific type of behavior, because the enrichment program was not designed to increase a particular type of behavior. However, the application of the different types of environmental enrichment to elephants was an incentive to increase or decrease some of the behaviors depending on whether or not the enrichment was applied. Statistically significant differences ($P < 0.05$) were observed in the frequency of some elephant behaviors.

When the animals received the environmental enrichment there was a greater frequency in the maintenance behaviors, eating (375), gait (281), playing (190), exploring (181), searching (71) and sniffing (42); eating was the more increased

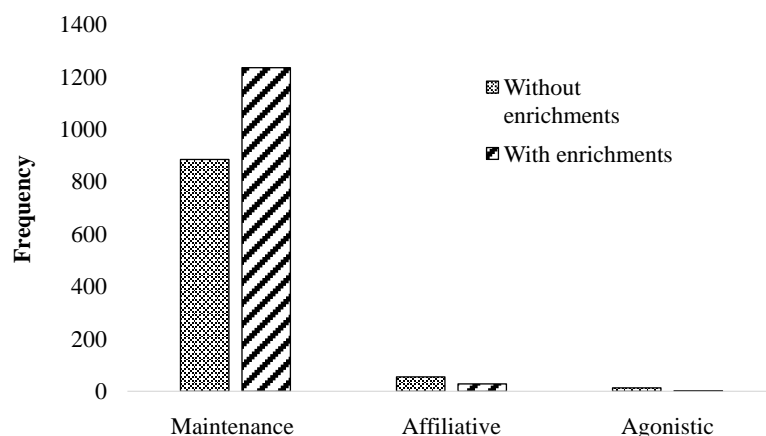


Figure 9. Frequency of behavior in captive Asian elephants (*Elephas maximus indicus*) with and without environmental enrichment.

behavior during observations with environmental enrichment. On the other hand, also with environmental enrichment some maintenance behaviors decreased, observing the following frequencies: standing (34), wobbling (17), sand baths (10) and trunk swinging with a reduction to (6), whereas without enrichment all these increased their frequency (Figure 10).

When the type of behavior (maintenance, affiliative or agonistic) was analyzed according to the enrichment applied, there were no statistically significant differences ($P > 0.05$). However, regardless of the enrichment used, the highest frequencies observed were those of maintenance behaviors (Figure 11).

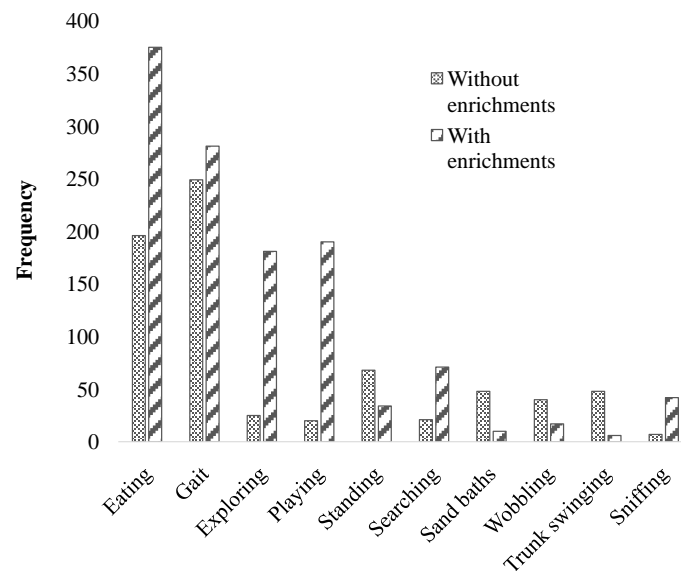


Figure 10. Behavioral actions presented with or without environmental enrichment in Asian elephants (*Elephas maximus indicus*).

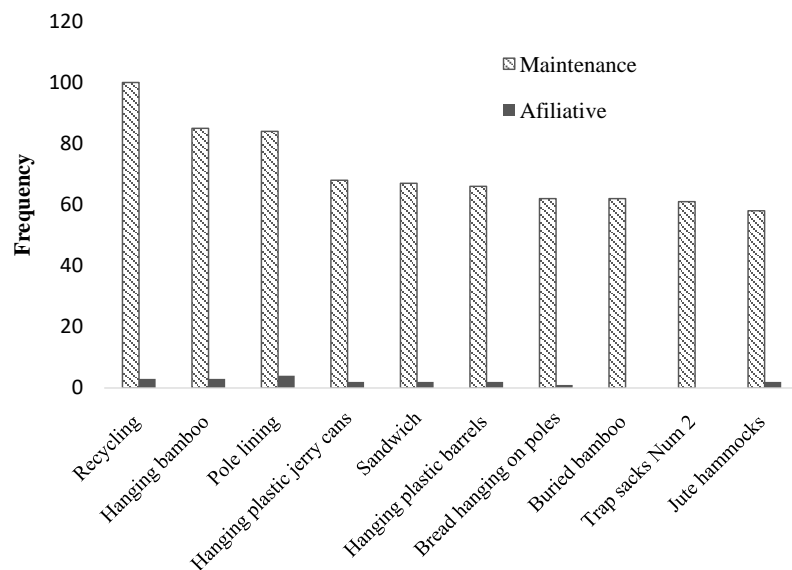


Figure 11. Types of behavior presented according to the 10 most frequent enrichments applied in Asian elephants (*Elephas maximus indicus*).

4. Discussion

Elephants are strong, intelligent animals with social needs, which is why the institutions that possess these magnificent animals understand the important financial and ethical human commitments involved in the maintenance and welfare of these specimens [17]. The management of Asian elephants (*Elephas maximus indicus*) in zoos and conservation parks involves a variety of practices including feeding, exercise, training and environmental enrichment; these practices are necessary to meet nutritional and healthcare needs [18].

Evidence accumulated years ago shows that the conditions of captivity imposed on animals in zoos can lead to problems related to their behavior [19]. The introduction of different enrichment elements into the animal enclosure allows group members to use enrichment individually and thus decreases tension and prevents fights [20].

Numerous studies with various species of zoo animals such as lions [21], marmosets [22], chimpanzees [23], orangutan [24], lemurs [25], and African wild dogs [26] have demonstrated the positive impact of environmental enrichment on well-being outcome including physiological responses to stress and boredom. However, there are few published studies on enrichment for elephants [18].

The environmental enrichment applied to the individuals encouraged them to express mostly maintenance behaviors, typical of the species, such as thermoregulation; which animals perform by putting on their backs part of their food when it is alfalfa or oats; or exercise sand or mud baths when they are exposed to the sun. However, there are several behaviors that, if increased, would not demonstrate the benefits of the application of enrichment. For example, wobbling is a normal behavior in elephants in captivity, but at the same time unwanted. Also, for visitors, it is not very pleasant to observe them wobbling for long periods of time.

Standing is also a behavior that decreases with the application of enrichment, thus increasing daily physical activity. It is always favorable that the behaviors of exploration, searching for food, and recreational behavior increase, since they are maintenance behaviors that improve the welfare of elephants; these behaviors are frequently presented by individuals in free life. In the wild food resources are dispersed temporally and spatially, elephants then use a variety of foraging skills to locate and access food resources [18].

In this study, the elephants considerably increased their physical activity as a result of enrichment application; specimens walked more due to the increase in playful behavior, exploration, and food search. Conversely, in the absence of environmental enrichment, elephants decreased search and exploration behaviors because the daily diet supply was not a novelty. Similarly, Brown *et al.* [27] determined that elephants do best in more natural environments that are enriching and meet the social needs of the herd. Those authors noted it is important that diets and exercise are balanced to ensure that body condition and metabolic functions are healthy.

5. Conclusion

Therefore, it is convenient for the conservation park to establish an environmental enrichment program. It was proved that if frequency is increased, notable improvements in behavior occur. Elephants are kept busy, performing different activities daily, which it is good for animals. Moreover, it is also pleasant for visitors to observe elephants carrying out recreational activities in the exhibition area. That is, in the absence of enrichment the elephants do not move for longer periods. It is more likely that they get bored or stressed. On the contrary, with environmental enrichment, teamwork is promoted. This allows the caregivers to know with daily observations the improvements in the welfare of elephants in the area, and enrichment can be made with materials typically found in the zoo.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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