

The effects of environmental enrichment on a group of captive spider monkeys (*Ateles geoffroyi*)

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Original article

SUMMARY

Captive animals suffer from stress and lack of stimulation. Environmental Enrichment provides them with a series of activities that encourage them to present species-specific behaviors. The objective of this work was to analyze the effects of an environmental enrichment (EE) program on the behavior of a colony of seven spider monkeys. It was expected that aggression, coprophilia and stereotypies would be less frequent, while exploration and play would increase. The study was divided into two phases: one prior to EE and one while EE was being implemented. A focal sampling per behavior was undertaken in 1 hr continuous recordings for a total of 40 hours per stage. We compared the frequency of each behavior with a Wilcoxon's signal test. The results showed that aggression, stereotypies and coprophilia were reduced during EE, while exploration and play increased significantly. No significant differences were found between sexes. EE reduces the problems caused by confinement; therefore, its continuous employment must be considered a necessary tool to make improvements to the living conditions of confined individuals.

Key words: Behavioral change, animal welfare, environmental enrichment, *Ateles geoffroyi*.

RESUMEN

Los animales que viven en cautiverio padecen problemas relacionados con el estrés y la falta de estimulación. El enriquecimiento ambiental (EA) proporciona a los animales en esta situación un conjunto de actividades que los alienta a presentar conductas típicas de su especie. El objetivo de este trabajo fue analizar el efecto de un programa de EA en la conducta de una colonia de siete monos araña (*Ateles geoffroyi*). Se esperaba que la agresión, la coprofilia y las estereotipias fueran menos frecuentes entre los monos, mientras que la exploración y el juego se presentarían con mayor frecuencia. Para ello, la investigación se dividió en dos etapas: una etapa previa al EA y una etapa durante el EA. En cada etapa se registraron las siguientes categorías conductuales: agresión, coprofilia, estereotipias, exploración y juego. Se utilizó un muestreo focal por conducta en registros continuos de 1 hr., obteniéndose en cada etapa 40 hrs. de observación. Al comparar la frecuencia de dichas conductas con la prueba de los signos de Wilcoxon, se encontró que la agresión, las estereotipias y la coprofilia disminuyeron durante el EA. La exploración y el juego se incrementaron significativamente con el EA. No se observaron diferencias significativas al comparar el sexo de los individuos. El EA disminuye los problemas causados por el confinamiento, por lo que debe contemplarse como una herramienta indispensable que de manera constante mejore las condiciones de vida en individuos confinados.

Palabras clave: Cambio conductual, bienestar animal, enriquecimiento ambiental, *Ateles geoffroyi*.

INTRODUCTION

Captivity causes extreme changes in animal behavior. In both human and non-human primates, an increase is observed in the frequency of aggressive behaviors towards other individuals and themselves,^{1,2} and self-directed stereotypy behaviors are developed such as hair pulling, pulling extremities, and pacing in a circle.²⁻⁴

Specifically in non-human primates, further to the above, major inactivity is also observed, as well as fewer locomotion and playing behaviors, and periods of sleep are greater in comparison to animals of the same species who live in the wild.⁵⁻⁷ Furthermore it is known that aggressive, stereotyped, and coprophilic behaviors are indicators of stress or boredom levels,^{8,9} while behaviors such as exploration and playing are indicators of individuals' wellbeing.¹⁰

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Environmental Enrichment (EE) is a set of actions that provide a stimulating environment for captive individuals with the aim of their behavior being similar to individuals in the same species who live in the wild, thereby seeking to promote the animals' wellbeing.¹¹⁻¹⁴

In recent decades, EE has had an important surge in application among non-human primates^{2,15-17} given that in laboratories, it is possible to not only minimize the effects of confinement,^{18,19} but the results obtained in aberrant behavioral studies and alternatives to reduce them are useful for medical science.^{1,3,20} Given that humans with certain mental problems or in a state of imprisonment have similar behaviors to those found in captive non-human primates, it is pertinent to implement activities which in this case are known as Occupational Enrichment.²¹

In non-human primates, strategies that could be developed can be grouped into three types of Environmental Enrichment according to their aim. a. *Physical enrichment* consists of increasing complexity in the environment, adding structures on the ground, the walls, and the ceiling, which allow the space to be divided into functional areas.^{2,22,23} b. *Dietary enrichment* includes activities that allow monkeys to increase the time and effort spent feeding themselves, including foraging; in order to do this, timetables were alternated as well as the way in which food was provided.^{2,13,22-24} Finally, c. *introduction to new objects* has the aim of compensating for the lack of manipulable objects within the cages. Toys and other objects are provided for this purpose which individuals can manipulate.^{2,13,22,23}

Reports of the benefits of EE are numerous: in humans in prison, for example, it has been seen that stimulation of exercise activity such as productive work, and even food preparation and studying, greatly favors the avoidance of violence.²¹

In spider monkeys, it has been demonstrated that behavior is affected by type of enclosure, for example, Cardona-López and collaborators²⁵ compared the behavior of a colony of *Ateles fusciceps robustus* that lived in a cage with another colony that lived in conditions of semi-freedom. The authors found that the animals in captivity dedicated more time to resting and eating, whereas the animals in semi-freedom spent more time on social interaction and movement. Furthermore, the group that lived in the cage showed more stereotyped behaviors than the animals that did not.

Torstenson²⁶ assessed three types of dietary enrichment activities with Colombian spider monkeys (*A. fusciceps rufiventris*) to find out which type of activity was most attractive to the monkeys in terms of the time spent doing it. The author found that the monkeys preferred "food puzzle" activities more than "ice blocks" or "stick ball" activities. It was also observed that there is more inactivity in individuals when EE activities are not applied, and that the animals lost interest in activities as the food involved in those activities finished.

Table 1. Individuals in the colony at the time of study

Individual	Code	Sex	Age
Adrian	AD	Male	Adult
Canica	CI	Female	Adult
Celina	CE	Female	Adult
Frida	FD	Female	Adult
Kifir	KI	Male	Adult
Leakey	LK	Male	Adult
Lola	LO	Female	Adult

In the National Institute of Psychiatry Ramón de la Fuente Muñiz in Mexico City, there is a colony of spider monkeys (*A. geoffroyi*) in which stereotypies, aggressive behaviors, and coprophilia were frequent; furthermore the monkeys had been in captivity for ten years with no formal EE program. Because of this it was necessary to offer them a better quality of life by means of applying an Environmental Enrichment Program.

It was expected that with EE, there would be a decrease in the frequency of aggression, stereotypies, and coprophilia, while exploratory and playing behavior would be more frequent in the monkeys. The aim of this work was to assess the effect of a comprehensive Environmental Enrichment program applied to a group of spider monkeys (*A. geoffroyi*) in captivity.

MATERIAL AND METHODS

At the time of the study, the colony was made up of seven adult spider monkeys; four females and three males (Table 1).

Since 1989, the monkeys have lived in a colony in outside captivity in a conical-shaped cage 19.8 feet long, 20.6 feet high, 20.3 feet at its widest part, and 5.6 feet on its narrowest side.²⁷ In order to compare the effects of the Environmental Enrichment program, the research was divided into two

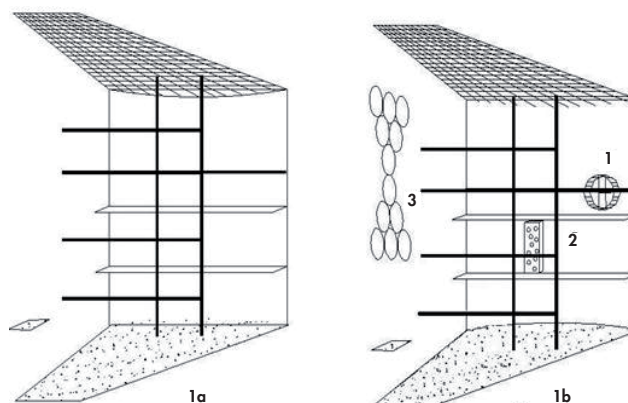


Figure 1. Cage layout. 1a. Cage conditions in Initial Phase. 1b. Physical enrichment: structures added to the cage as part of environmental enrichment. 1. Exercise wheel, 2. Foraging panel, 3. Hoop set.

Table 2. Environmental Enrichment Program Activities

Activity	Description
Food in bottles	Promil branded 800 gm formula milk bottles were used. A wire mesh was placed in the upper part of the bottle. Fruit was placed inside the bottle and it was given to the monkeys for them to take the food out.
Food in a sack	The food corresponding to a certain day was placed inside a burlap sack and tied up. This was then given to the monkeys.
Food on the ceiling	The fruit corresponding to a certain day was placed on the ceiling grid in the cages.
Bottles with seeds	Birdseed, sunflower seeds, and wheat were placed in aluminum bottles that previously held JUMEX Brand juice. The bottles with seeds were given to the monkeys.
Foraging panel	The foraging panel is a sheet of metal with holes in it. Inside each hole there is a metal tin where seeds can be placed. During each session with the foraging panel, sunflower seeds, birdseed, wheat, rice, oats, and breakfast cereal were placed in the tins.
Balls	Plastic balls were used which were 12 inches in diameter. The balls were placed in the containment cage, which was later opened for the monkeys to take the balls out.
Branches and leaves	Branches with <i>Ficus sp.</i> and <i>Pinus sp.</i> leaves were placed on the ceiling grid of the cage.
Roller	The roller is a metal cylinder 8.6 inches long by 4.3 inches in diameter. A metal tube goes into the cylinder and sticks out of each end of the cylinder by 3.9cm. At each end of the roller where the cylinder meets the tube, there is a bearing which allows the roller to roll.
Seeds	Sunflower seeds, birdseed, wheat, rice, and oats were put through the ceiling mesh of the cage, and the monkeys could pick them up straight from the floor.
Rattles	Cardboard tubes 1.6 x 3.9 inches were covered with newspaper and paste made from flour and water. Within these cylinders were placed sunflower seeds, birdseed, wheat, rice, and oats.
Branches with holes	Small holes were made in Eucalyptus branches and inside were placed jelly, condensed milk, fudge, tomato sauce, mayonnaise, and honey.

phases: The phase prior to EE went from March 13 through May 26 2000. In this phase, the behavioral state of the animals was detected; during this time, no EE activity was carried out and the cages were simple (Fig 1a). This was known as the Initial Phase (IP). The second phase of the program took place between November 26 2001 and March 22 2002, during which the monkeys came into contact with the modifications made to the cage (Fig 1b) and the EE program activities were carried out. This phase was called the Experimental Phase (EP).

The types of Environmental Enrichment covered in the program were: physical enrichment, dietary enrich-

Table 3. Definition of the behavioral categories analyzed

Behavioral category	Definition
Aggression	Push, pull, swipe, bite, catch, or chase another individual with the aim of causing them injury. Self-aggression: behavior that implies injury to oneself.
Stereotypies	Repetitive movements that occur without concern for what is going on around them, such as hair pulling, cheek pinching, rocking the body.
Exploration	Observe, touch, or manipulate objects found in their surroundings.
Coprophilia	Touch, smell, observe and/or intentionally smear feces or urine (not necessarily one's own), either with the mouth or hand.
Play	Catch, shake, chase, or touch another individual or object without causing damage.

ment, and introduction of new objects. With the support of CONACYT's 25858-H Project, the cages were physically enriched, adding different structures which are shown in Figure 1b. As part of the introduction to new objects and dietary enrichment, 11 different activities were carried out (Table 2) which were each repeated three times. Each week, three different randomly-selected activities were applied on different days, until 33 sessions were complete. The activities were carried out at 10:00hrs and 16:00hrs alternatively.

In order to assess the effects of the Environmental Enrichment program on the animals' wellbeing, an observer with eight months' experience made records of behavior in the following categories: aggression, coprophilia, stereotypies, exploration, and play (Table 3).

Continuous records were made for 60 minutes using a focal sample per behavior²⁸ during both phases of the investigation. Records were between 08:00hrs and 19:00hrs and 40 hours of records were obtained for each phase. During the experimental phase, these records were made five days a week, regardless of whether or not there was EE activity.

Statistical analysis

In order to statistically compare the frequency of the behaviors displayed from one phase to the other, the Wilcoxon non-parametric signed-rank test²⁹ was applied, with a level of significance of $p \leq 0.05$. Each behavioral category and sex was analyzed independently. In order to carry out statistical calculations, the SPSS version 17.0 program for Windows was used (SPSS Inc, Chicago IL, USA).

RESULTS

The results show that in the colony of seven individuals, aggression, stereotypies, and coprophilia reduced in fre-

quency during the experimental phase; in the first two behavioral categories, the reduction tended to be statistically significant (aggression, $N=7$, $z=-1.841$, $p=0.063$; stereotypies, $N=7$, $z=-1.521$, $p=0.078$). On the other hand, exploration and play ($N=7$, $z=-2.366$, $p=0.008$, and $N=7$, $z=-2.214$, $p=0.016$, respectively) were significantly more frequent in the experimental phase (Fig. 2).

In order to gain knowledge of the effects of EE on both sexes, Wilcoxon's non-parametric signed-rank test was applied to the frequency of the behaviors shown by the three males and four females in the two phases of the program (Fig. 3). Aggression was less frequent in both males and females during the EE, without statistical significance ($nMales=3$, $z=-0.816$, $p=0.375$; $nFemales=4$, $z=-1.342$, $p=0.250$); the males attacked more than the females in the two phases. A decrease in coprophilia was observed in both sexes ($nMales=3$, $z=-1.342$, $p=0.250$; $nFemales=4$, $z=-0.365$, $p=0.438$), and the reduction in stereotypies tended to be significant in females ($nMales=3$, $z=-0.535$, $p=0.375$; $nFemales=4$, $z=-1.461$, $p=0.063$). Exploration during Environmental Enrichment was more frequent in both sexes; for females the change tended to be statistically significant with respect to the IP ($nMales=3$, $z=-1.604$, $p=0.125$; $nFemales=4$, $z=-1.826$, $p=0.063$). Finally, in the play

category, both males and females had an increase during the EP, but this was not significant ($nMales=3$, $z=-1.633$, $p=0.125$; $nFemales=4$, $z=-1.633$, $p=0.125$), and it was observed that the males played more frequently than the females in both stages of the program.

DISCUSSION

As expected, Environmental Enrichment achieved a reduction in aggression, stereotypies, and coprophilia, while the frequency of exploration and play behavior increased, enabling us to call the applied EE program a success.

The fact that no differences were found in exploration among the females could be due to the three males monopolizing the objects. New experiments would have to be conducted which increased the availability of objects. In terms of the increased play in males, without the difference being significant in terms of the females, it could be suggested that this behavior allows males to integrate themselves within the group, occupying a place in the hierarchy.³⁰

In providing some sort of EE activity, it is vital to consider the species being worked with, given that the individ-

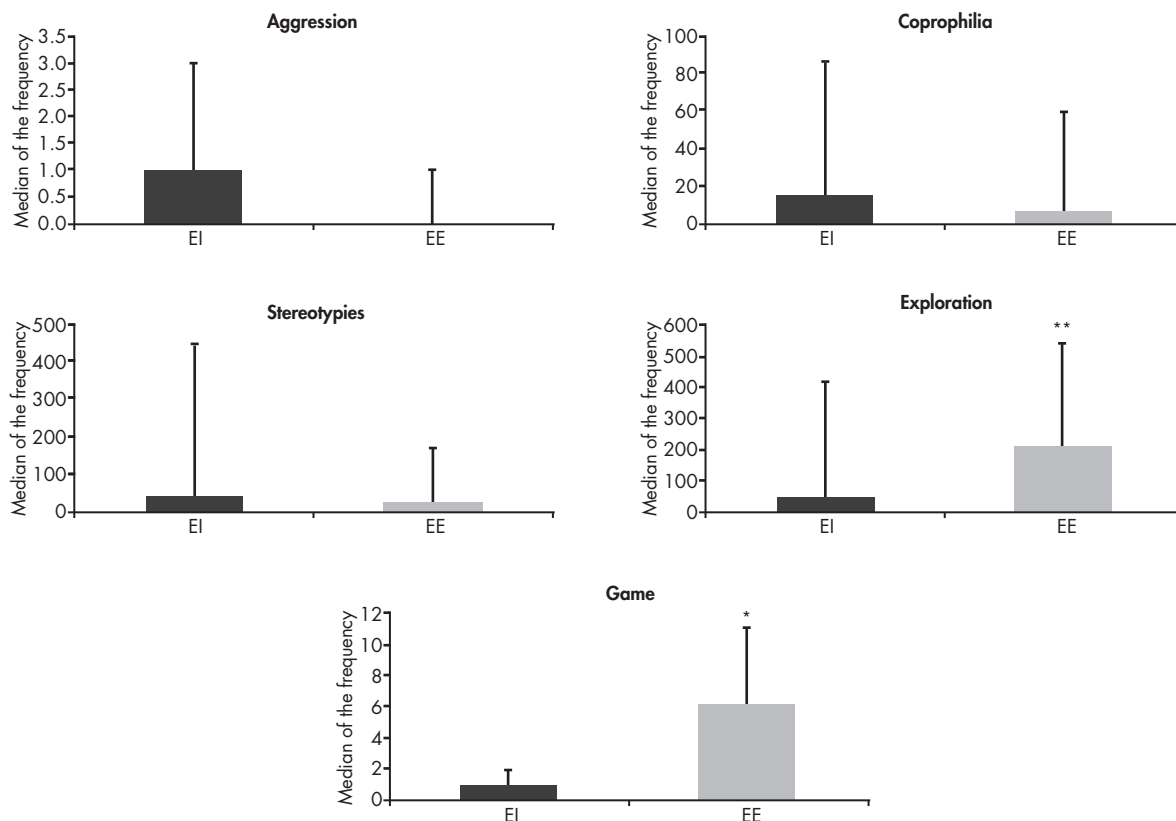


Figure 2. Comparison of the frequency of the behavioral categories analyzed in both phases of environmental enrichment. Median of the frequency and range of each behavioral category analyzed in the initial phase (IP) and in the experimental phase (EP) of the environmental enrichment. (*) indicates that $p \leq 0.05$, (**) indicates that $p \leq 0.01$.

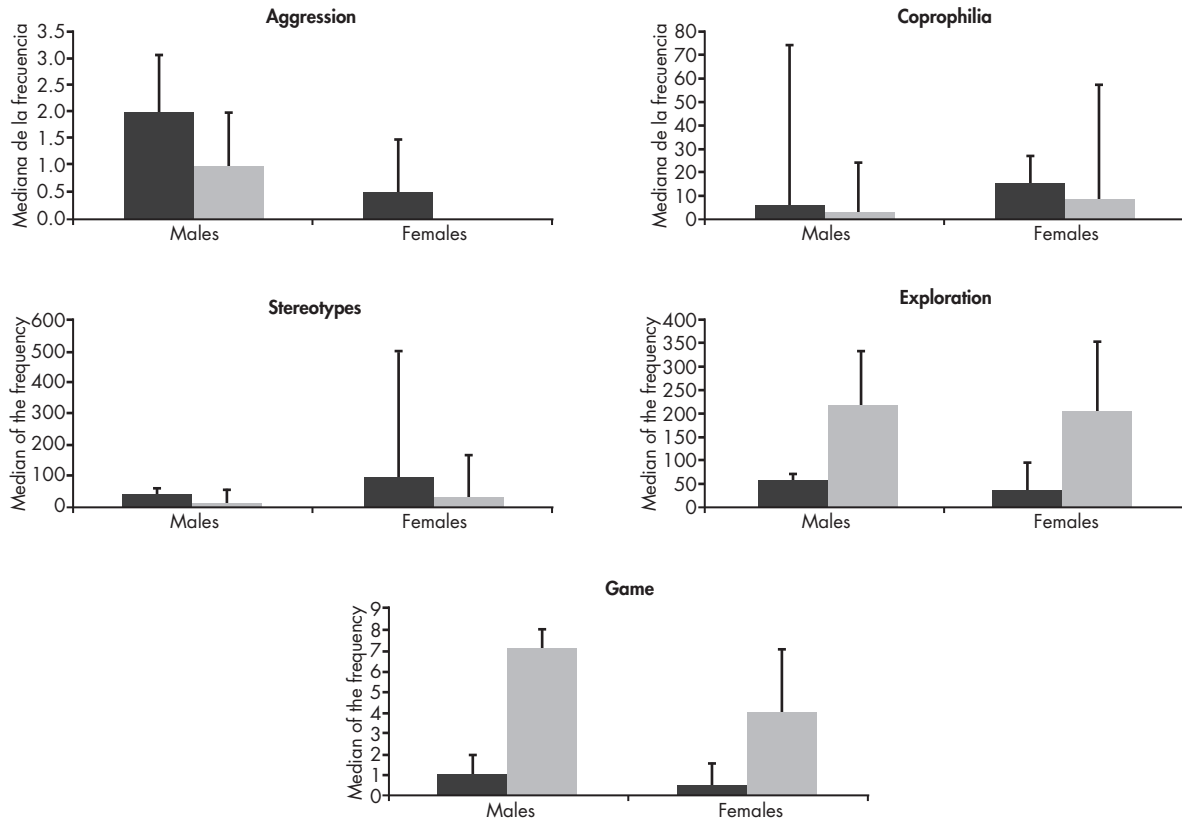


Figure 3. Comparison of the frequency of the behavioral categories analyzed in both phases of environmental enrichment considering individuals' sex. Median of the frequency and range of each behavioral category analyzed in the initial phase (IP) and in the experimental phase (EP) of the environmental enrichment considering the individuals' sex. Dark bars = initial phase, light bars = experimental phase.

uals' response will depend on this, as structures, dynamics, and interactions differ between species. However, given the serious conditions in which the spider monkeys in this study were found, a general Environmental Enrichment program had to be applied to the colony as a matter of urgency. The same was true of a colony of stump-tailed macaques (*Macaca arctoides*) which was also found in the National Institute of Psychiatry.¹⁹ Due to this, the activities had to meet the needs of both species, observing that the animals in both colonies improved their behavior with these activities. It is worth commenting on experiences that were observed during the recording for consideration in future works. Activities such as "food on the ceiling", "food in bottles", and "rattles" caused the monkeys to get up and move objects around the cage. The "trunk" and "roller" activities kept the monkeys' attention due to the curiosity of the situation. On the other hand, despite the assumption that activities such as collecting seeds from the ground would be difficult for the spider monkeys due to their species anatomy meaning that the thumb is reduced to aid brachiation,³¹ we found that the novelty of the activity and the reward of being able to eat the seeds encouraged the animals and as a result they spent time on this activity. It was also observed that the spi-

der monkeys immediately approached and manipulated the objects, and after 30 or 45 minutes, they no longer showed interest. This was similar to that reported by Torstensson²⁶ who mentioned that spider monkeys lose interest when the food is finished. Because of this, it is important to change the activities, objects, time, and way in which these are presented in order to keep the individuals active.

The proposal of this work was to provide a novel physical environment which would arouse the animals' interest, on the basis that Environmental Enrichment activities are concentrated on enriching the cage and offering different food-related activities and the introduction of new objects. It is known that it is necessary for EE programs to consider the social environment which is very important for primates, and that whenever possible, having contact with other individuals improves behavior.³² However, in this case it was not necessary to implement social enrichment strategies as the animals already lived in a group.

In the case of Occupational Enrichment in human primates, it would also be necessary to consider the physical and mental characteristics of the individuals, as well as social, political, and cultural aspects of the population for the activities to be fully taken advantage of. It should not

be forgotten that by their nature, prisons and hospitals are physically poor and due to the situation of confinement, it may not be possible to improve this. However, it is fundamental to take on the fact that these people deserve better living conditions, which in the case of prisoners allows them rehabilitation, the whole point of imprisonment. Lack of activities implies a decline in the social skills of the individuals and has repercussions on their reintegration into society. Occupational Enrichment enables alternatives to be offered to prisoners and favors individual, social, and cultural growth.

It will be especially interesting to develop EE programs in non-human primate models over the longer term in order to obtain relevant information which contributes to understanding the processes of loss in primates.

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