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ORIGINAL ARTICLE

Induced Tool Use as Environmental Enrichment for Captive Capuchin Monkeys (*Sapajus libidinosus*)

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ABSTRACT - We tested the effect of an apparatus that could induce tool use on the behavior of six captive Capuchin Monkeys. We used "focal-animal" to estimate the time spent in general behavioral states and those indicative of stress, and "all occurrences" of agonistic and stereotypic behavioral events. The group showed different profiles of activity budget, with varied responses to stressing factors. Some individuals reduced the behaviors indicative of stress, but there was no significant variation for the group. We concluded that the apparatus was inefficient, limited as measure of enrichment for the species. However, due to individual effects, we suggest that the technique can be effective for specific individuals or groups under very stressful conditions.

Keywords: animal welfare, cognitive enrichment, stress, primates

Indução do Uso de Ferramentas como Enriquecimento Ambiental para Macacos-prego (*Sapajus libidinosus*) Cativos

RESUMO - Testamos o efeito de um aparato que pudesse induzir o uso de ferramentas no comportamento de seis macacos-prego cativos. Utilizamos "animal focal" para o tempo gasto em estados comportamentais gerais e estados indicativos de estresse, concomitantemente com "todas as ocorrências" de eventos agonísticos e de comportamentos estereotipados. O grupo mostrou perfis de orçamento de atividades diversificados, com respostas variadas aos fatores estressantes a que estavam expostos. Alguns indivíduos reduziram alguns comportamentos indicativos de estresse, porém não houve variação significativa para o grupo. Conclui-se que o aparato não foi eficiente, mostrando suas limitações como medida de enriquecimento para a espécie. Em razão dos efeitos individuais, sugerimos, no entanto, que a técnica possa ser eficaz em grupos específicos ou condições muito estressantes.

Palavras-chave: bem-estar animal, estresse, enriquecimento cognitivo, primatas

Captive primates should be lodged in groups and kept in enriched environments. This would provide them the opportunity to perform activities typical to their species (Mason, Clubb, Latham & Vickery, 2007). A satisfactory definition of the proper captive environment for these animals is based on the "behavioral-ecological criterion". According to this criterion "a good captive environment will be one that maintains in the captive population all of the motoric, social, cognitive, and other skills that would be needed by the animals to survive in the wild if they were to be reintroduced" (Snowdon, 1994, p. 220).

Capuchin Monkeys (*Sapajus sp.* and *Cebus sp.*) are Neotropical primates that, theoretically, should be well-adapted to enriched captive environments. In nature, they have a broad and extremely flexible behavioral repertoire, omnivorous and generalist diet, and extractive and opportunist foraging strategies (Fragaszy, Visalberghi & Robinson, 1990; Mendes et al., 2015). For the *Sapajus* the groups typically use tools and/or proto tools, employing creative and many times complex solutions to reach their objective (e. g. Coelho et al., 2015; Ottoni, 2015; Verderane, Izar, Visalberghi & Fragazsy, 2013). Moreover, they are very nervous, exploring a wide range of environments. Therefore, the Capuchin Monkeys usually are well-adapted to environmental and seasonal variations, surviving in much altered environments (Fragaszy et al., 1990).

On the other hand, the artificiality of the captive environment and the kind of management used may make the individuals become apathetic, aggressive and present high rates of abnormal behaviors, indicating stress (e. g., Boere, 2001; Newberry, 1995). In these cases, we can observe reduction of typical behaviors, like social and manipulation, and longer downtime and periods of stereotyped and self-directed movements (Bariani, 2007; Jacobsen, Mikkelsen & Hau, 2010; Santos & Reis, 2009; Westergaard & Fragaszy, 1985).

Studies on environmental enrichment for Capuchin Monkeys are typically carried out with apparatuses that demand simple food manipulations (i.e., handle with or carry). The results show some improvements of the welfare of individuals, such as increased foraging, manipulation of objects and locomotion. It also reduced stereotyped actions such as roaming and turning the head. Satisfactory levels of cortisol were also achieved (e. g. Boinski, Swing, Gross & Davis, 1999; Jacobsen et al., 2010; Lessa, 2009; Westergaard & Fragaszy, 1985). Therefore, one could expect that the enrichment apparatus that induce

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the use of more sophisticated manipulation (i.e., use of tools) would generate even more satisfactory results. In fact, the (flexible) use of tools is a complex activity that involves senses, problem solving (i.e., cognition), heightened motoric capacity, feeding the relationship with the physical and social means (Call, 2013; Hunt, Gray & Taylor, 2013). In the case of chimpanzees, for example, the induced tool use (probes to get ants) expanded the subjects' social contact and level of activities, besides stimulating their cognition (Celli, Tomonaga, Udono, Teramoto & Nagano, 2003). Finally, it is not unusual for captive Capuchin Monkeys to spontaneously use tools (e. g. Haslam, 2013; Mendes, Martins, Pereira & Marquezan, 2000). Therefore, there are great chances of interacting with devices that facilitate this behavior.

Despite its apparent usefulness, only one study employs induced tool use as a way of environmental enrichment for captive Capuchin Monkeys (Mendonça-Furtado, 2006). In this study, toys, a foraging device and the delivery of stones and coconuts have no effects on the hormones and on behaviors that could indicate stress in the group. The attempt to induce tools use, in particular, had little impact on the group - only four of the 11 subjects successfully used the stones as a percussive tool to break coconuts. Unexpectedly, these potential enrichments did not led to significant improvements on the animals' welfare. The author suggest, as likely causes of the failure of her intervention, the short time of exposure of animals to the artifacts, lack of attractiveness of the devices introduced, and the possibility that animals, in principle, were not in high stress condition.

Capuchin Monkeys are very usual in zoos all over the world. They are frequently used as experimental models in laboratories (including studies about anxiety and stress – e. g., Le et al., 2016; Vasconcelos et al., 2015). Finding good ways to keep these animals in zoos and labs is important to minimize the negative effects of captivity and the likely costs of improper handling to the institutions maintaining them. Therefore, trying again the induced tools use as a way of enrichment is very relevant in the practical light.

This paper aims to test the effect of an apparatus that could involve the use of probes as environmental enrichment for a group of captive Capuchin Monkeys (*S. libidinosus*). Some wild (Falótico & Ottoni, 2014; Mannu & Ottoni, 2009) and captive (Westergaard, Lundquist, Kuhn & Suomi, 1997) populations of this species have spontaneously used sticks as probes to have access to food. Although this is not a behavior typical to the species, the groups observed performed this practice in different and complex ways, many times involving changes to the objects that were used. We have also observed the induced artificial probes use in wild groups of *S. libidinosus* (Cardoso, 2014). This way, we expected the subjects of our study to successfully perform this activity if we provided them with the required objects and conditions. We also expected that the technique employed would be a good way of environmental enrichment. We hoped it could reduce the rates of abnormal behaviors, such as stereotypies and self-directed behaviors, reducing the performance of agonistic behaviors and increasing the performance of typical behaviors, like the manipulation of objects.

Methods

Subjects and the Study Site

The study group comprised six Capuchin Monkeys (*Sapajus libidinosus*) in the Zoo in Brasilia (DF): two males (M1 and M2) and four females (F1 to F4), all adults, and F4 was old. All subjects were apprehended from illegal breeding. Based on the agonistic interactions with M2, on the copulations and priority access to food, we suppose that M1 is the *alpha* male in the group.

Subjects were exposed to the public on an open ellipse--shaped space in the middle of a lake, of about 150m². On the center of the space there was a 2-floor wooden platform with two small houses for the animals to take shelter (one on each floor of the platform) and a stone cave on the surface. The space was also furnished with artificial perches made up by seven wood trunks connected one another and to the platform with fiber tapes, placed on the island sides. The monkeys were fed everyday with fruits, vegetables and leaves, with free access to the water from the lake.

Materials

The environmental enrichment apparatus was a 12 x 12 x 12 cm acrylic box with a tap on the top, with four holes of 3cm in diameter each, and rods of about 28cm in length and 0.5 cm in diameter, made of wooden toothpick (see Figure 1). About 100 ml of honey diluted in water (60% - 40%) was put in the box. The apparatus was used to induce animals to use the rods to get the honey, making their foraging activity more complex, involving the solution of problems and manipulation of objects like tools.

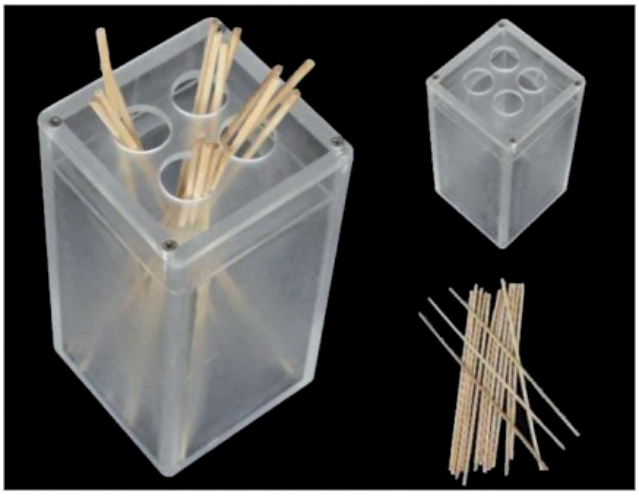

*Figure 1***.** Environmental enrichment apparatus.

Because of the number of animals and the short size of the apparatus, we decided to use two acrylic boxes. Each box was fixed on one of the wood poles that sustain the platform on the island, 1.5 m far one from the other. For each box, 16

rods (four on each hole), in contact with the honey, were made available. By the end of each observation day, the boxes and the rods were collected. This way, animals would not have contact with these out of the study times.

Procedure

The study was made up by three phases. The first one consisted in observations with no intervention (Baseline - BL) and took five weeks. In the second phase (Treatment) we introduced the environmental enrichment apparatus, interspersing weeks with (Treatment A - Ta) and without (Treatment B - Tb) use. This phase lasted 10 weeks, i.e., five weeks with the apparatus on the space and five without it. This was important to prevent animals from getting used to the apparatus, and to test likely short-term effects caused by it. In the third phase (Verification - VE) we analyzed the animals' behavior after the intervention to investigate potential long-lasting effects of the technique employed. This phase has also lasted five weeks.

In all phases, data were collected three times a week in the evening period (12:00 17:00). We have used three sample methods (Altmann, 1974; Martin & Bateson, 2007). The "focal animal" method with continuous records was used to quantify the time spent in general behavioral states (eat, forage, move, rest and manipulate objects) as in states indicating stress (self-directed behaviors and pacing). The records of manipulating objects did not include the issue of the apparatus introduced in the environment. Self-directed behaviors included self-grooming, self-huge, self-care (scratch, clean and/or lick the body) and manipulation of their own tails. Pacing was defined as to walk or run repeated times, not necessarily on the same path, and with no clear objective. Each subject was observed for two 15-minute period every collection day. The second observation was only after all monkeys had been sampled once during the day. The order of observation of each animal followed a system of rotation, as follows: The first subject to be observed in the first session was the last to be sampled on the following session. Therefore, the time of collection of each animal changed. There was a 3-minute interval between the focal samples to avoid repetitions of interactions. The waiting time between the first and the second sessions was 15 minutes.

Concomitantly, we used the focal group method with "all occurrences" records of agonistic interactions events (threats and explicit aggressions) and of stereotyped behaviors (turn the head and bend the body). Here, a second observer consistently recorded the data, independently if the observed involved or not a subject being sampled in "focal animal". Finally, on days when we used the apparatus of environmental enrichment, we also used the scan method with instantaneous records every two minutes. It aimed to estimate the time spent by each subject in actions related to it (Table 1).

Altogether, there were 17 hours of observation in "focal animal" and 188.1 hours in all occurrences to the group of subjects, distributed over 59 days of collection from June 13 to December 12, 2011 During the phase of treatment using the apparatus, 1245 scans (average 83 a day) were made, distributed along 41.5 hours of observation. For the analysis, we disregarded focal samples shorter than ten minutes of effective observation (i.e., when the animal stayed long time out of the observation field). The number of focal samples for each subject in each condition is shown in Table 2.

Table 1. *Ethogram to collect behavioral data referring to the scan method.*

Parts of the apparatus	
Rod	Use only the rod.
Box	Use only the box.
Rod-Box	Any form of contact between the rod and the box.
Action	
Manipulate	Handle the rod without characterizing any other action.
Carry	Carry the rod from one site to another using the hands or the tail.
Sensorial	Smell or stare at the rod or the box.
Probe	Use the rod as tool (insert) to have access to the honey in the box.
Shake	Shake the box, apparently trying to wrench it.
Introduce the hand	Put the hand in the box
Remove the rod	Only remove or introduce the rod in the box (differently from the probe that includes both actions).
Lick	Pass the tongue along the rod or in the box.

Table 2. *Number of focal samples performed by subject, distributed by phase.*

Subject	**Phase**				**Total**
	BL	**Ta**	**Tb**	**VE**	
M1	30	30	28	24	112
F1	29	28	24	21	102
F2	30	31	26	25	112
M2	30	29	26	23	108
F3	28	25	22	23	98
F4	29	29	27	24	109
Total	**176**	**172**	**153**	**140**	**641**

BL = Baseline
Ta = Treatment using the apparatus
Tb = Treatment not using the apparatus
VE = Verification

All procedures carried out in this survey were approved by the Committee of Ethics in Animal Use of the Biology Institute, of the *Universidade de Brasilia*, previously to data collection.

Data analysis

We have used the software SPSS 18.0. To evaluate the use of the environmental enrichment apparatus, first we pooled the categories of action (see Table 1) in four types, according to the adequacy and efficiency of the use of the tool and of the apparatus: Success (probe); alternative (access to honey by other means - introduce the hand and lick); association (association between the rod and the box, without achieving the objective - remove the rod); and, handling (manipulate, carry, shake and sensorial). Based on these percentage values, we built a hit rate (when the individual has access to the honey): Sum of "success" and "alternative" to each monkey divided by the number of scans in which it used the apparatus, further multiplied by 100.

To evaluate the likely effects of the enrichment, we applied the ANOVA statistical test of repeated measures ($p<0.05$) using simple contrast - comparing the baseline with the remainder conditions. For data that violated the condition of sphericity, the Greenhouse-Geisser's correction (Stereotyped Behaviors and Agonistic Interactions; Mauchly's test, $p = 0.018$ and $p = 0.020$, respectively) was used.

Results

Baseline

Subjects presented widely varied profiles of time budget for general activities (eat, forage, move, rest and manipulate objects). This suggests little synchrony of behaviors and low intragroup cohesion. In relation to the indicative states of stress (self-directed behaviors and roaming), there were also lots of intrasubject variations. The group spent 6.83% of the time in these activities (1.61% in self-directed behaviors and 5.22% in roaming), ranging from 0.11% to 5.32% and from 0.31% to 13.98%, respectively. The highlight was subject F4 for self-directed behaviors (5.32%) and F2 for roaming (13.98%).

The relative frequency of behavioral events also varied between subjects. The rates of occurrence of agonistic behaviors were relatively low for five of the six individuals (of 0.03 to 0.32, with 0.15 events/hour on average. However, M1 presented high value (1.68). In relation to the stereotyped behaviors, the intragroup variation was the highest one: of 0.09 to 25.89 by hour of observation (occurring from 5 to 1425 times between the subjects), being more executed by the subjects F1 (25.89/hour) and M1 (18.66/hour).

Use of the Environmental Enrichment Apparatus

Subjects presented great differences in the percentage of use of the apparatus and in the hit rates in this use (Table 3). Regarding the use, values ranged from 3.53% (F3) to 16.55% (M2) of the time budget; in relation to hit rates, this variation was from 19.79% (M1) to 90.78% (M2), where the subjects F3 (79.55%), F1 (69.23%) and F2 (60%) were outstanding. The male M1, supposedly the *alpha* male, presented median use of the apparatus (7.71%) with the lowest hit rate (19.79%) when compared to the remainder group members. In opposition, the females F3 (3.53%) and F2 (3.61%) presented the lowest values of the apparatus use, but reached relatively high hit rates (79.55% and 60%, respectively). M2, in turn, reached high numbers both in the apparatus use (16.55%) and hits in this use (90.78%).

Table 3. *Use of the environmental enrichment apparatus, number of occurrences of each type of action and hit rate referring to this use by each subject.*

Subject	Action				Total	UA (%)	HR (%)
	AL	ASS	HA	SU			
M1	13	0	77	6	96	7,71	19,79
F1	3	1	31	69	104	8,35	69,23
F2	4	0	18	23	45	3,61	60
M2	3	2	17	184	206	16,55	90,78
F3	0	0	9	35	44	3,53	79,55
F4	26	0	52	6	84	6,75	38,1

AL = Alternative
ASS = Associate
HA = Handle
SU = Success
UA = Percentage of time using the environmental enrichment apparatus
HR = Hit rate regarding the use of the environmental enrichment apparatus

Manipulation of objects

The manipulation of objects (except for the apparatus) has widely varied between the conditions ($F = 3.784$; $gl = 3$; $p = 0.033$) – Figure 2. When compared with the peers, the conditions Treatment A ($F=4.576$; $gl = 1$; $p = 0.021$) and Verification ($F = 3.142$; $gl = 1$; $p = 0.042$) differed from the baseline. In fact, the introduction of the apparatus extended the time spent in manipulative behaviors with other objects for five of the six animals (except for F4). This increase was expressive in F1, F2, M2 and F3. This increase remained in the Treatment B phase for the individuals M1 and F2. F1, F2 and F3 spent more time in manipulations during the Verification than in the initial phase. It is also worth mentioning that subjects M2, F1 and M1 present the highest percentages of use of the apparatus (16.55, 8.35 and 7.71%, respectively). Nonetheless, they increased the number of manipulations of objects in the second phase.

Behavioral states indicative of stress

The time spent in "Self-directed Behaviors" had no significant variation between the conditions ($F = 1.707$; $gl = 3$; $p = 0.208$ – Figure 3). Once again, the results were quite different between subjects. Female F4, which spent the longest time showing these behaviors on the Baseline (5.32%), substantively reduced these during the Treatment A and B phases (2.68 and 2.62%, respectively), drastically reducing these in the Verification phase (0.29%). F1 also presented significant

reduction in the Treatment B and Verification phases (of 1.65% on the Baseline to 0.19% and 0.15%, respectively). Female F3, in turn, reduced the execution of self-directed actions in Treatment A (of 1.49% on the Baseline to 0.19%), slightly increasing it in Treatment B (0.49%).

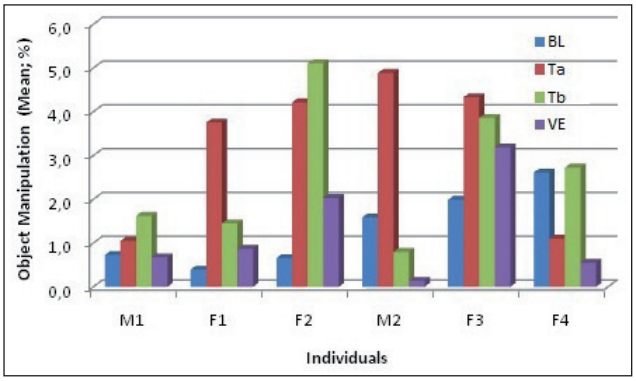

Figure 2. Time spent by subjects on manipulation of objects during the study phases. BL = Baseline; Ta = Treatment using the apparatus; Tb = Treatment not using the apparatus; VE = Verification.

There was no variation between the conditions for "Pacing" (F=0.549; gl=3; p=0.656 - Figure 3). Despite that, F2 - which during the Baseline presented the longest time allotted to the behavior of roaming (13.98%) - presented sharp decrease in this behavior from phase 2 onwards (Treatment). F1 has also shortened its time of exhibition in the Baseline (3.21%) for the Treatment B (0.40%) and Verification (0.96%) conditions. M1, however, showed significant increase (from 10.98% on the Baseline to 38.24% on Treatment A).

Behavioral Events Indicative of Stress

We found no significant value regarding "Stereotyped Behaviors" (F = 0.376; gl = 1.205; p = 0.601 - Figure 3). During Baseline, F1 presented the highest rate of occurrence of stereotyped behaviors in the group (25.89/hour), followed by M1 (18.66/hour). Although variation was not significant, F1 reduced the stereotypies rates to 18.11, 15.06 and 15.23 events per hour in the following phases. It did not happen to M1, however. In the second phase, its stereotypies rate had sharp increase (42.42/hour), with significant reduction in the third phase (28.19/hour) and increasing again in the fourth phase (33.58/hour). The male M2 has also reduced the occurrence of these behaviors in the two treatment conditions (0.77/hour for both), although it presented few stereotypies in the Baseline (3.93).

The rate of occurrence of "Agonistic Interactions" has not changed between conditions (F = 2.261; gl = 1.543; p = 0.172 – Figure 3). Nonetheless, the male M1, which presented the highest rate of Agonism on the Baseline (1.68/hour), greatly reduced this rate in the further phases (0.76, 0.86 and 0.24/hour in Treatments A and B and in Verification, respectively). Moreover, F2, M2, F3 and F4 reduced their rates of agonistic interactions in the final phase. Except for F3 (of 0.25 on the Baseline to 0.19 in Verification), all these subjects presented value equal to zero in the Verification phase.

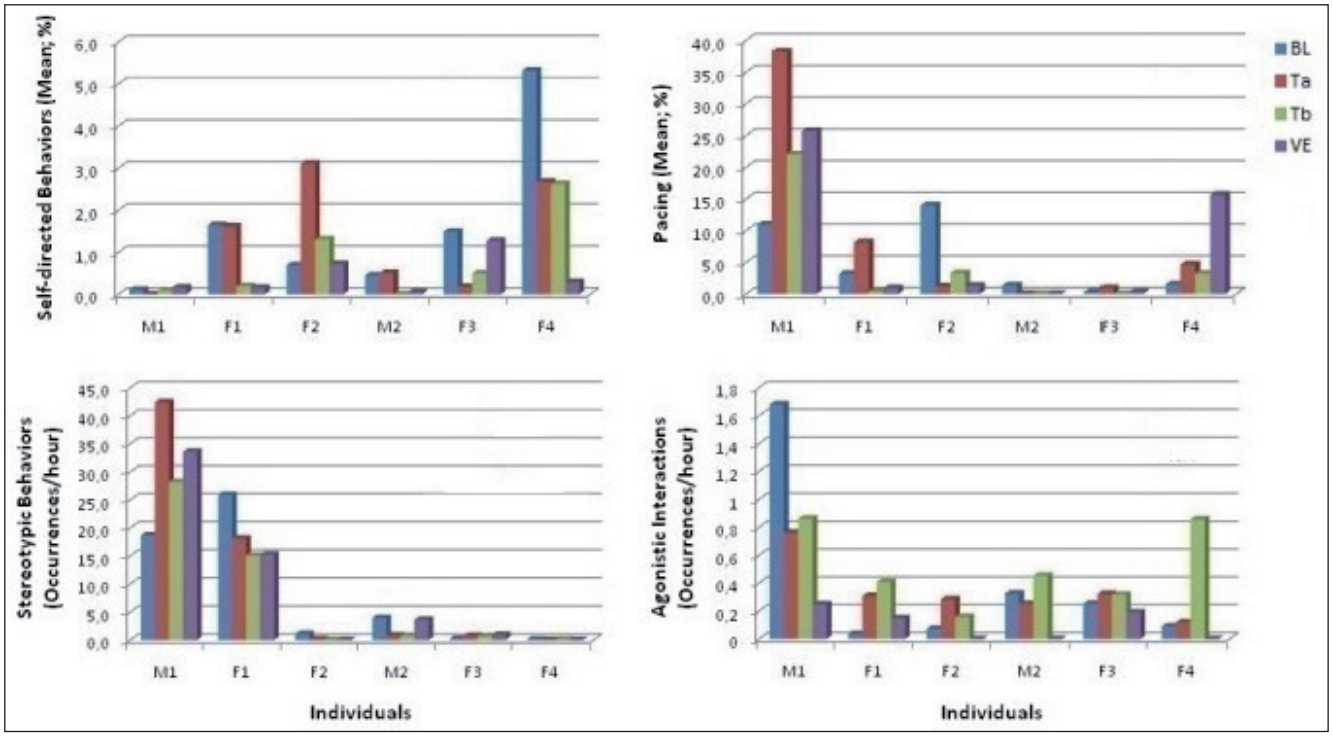

Figure 3. Time spent in self-directed behaviors and pacing, and frequency of occurrence of stereotyped behaviors and agonistic interactions by the subjects during the study phases. BL = Baseline; Ta = Treatment using the apparatus; Tb = Treatment not using the apparatus; VE = Verification.

Discussion

In our study, the only statistically significant effect was the expansion of the time spent manipulating objects. Since subjects spent part of the time using the apparatus, they might reduce the manipulations of other objects during the Treatment phase. However, it did not happen. As the enriching technique employed consisted in problem-solving (i.e., cognitive enrichment), the actions related with the use of apparatus may have instigated the monkeys to execute other activities involving the manipulation of objects. The opposite happened in the study of Jacobsen et al. (2010) where the manipulations in the initial stage were replaced by the use of the devices offered to the Capuchin Monkeys. The authors point as likely justification the fact that there was not object available on the space (on the baseline, the monkeys only manipulated parts of the gage). Therefore, the enrichments offered became "more interesting", leading to a reduction in other manipulation behaviors. It did not happen in our study, probably because of the large amount of objects (i.e., stones, sticks, leaves, plastic materials) available on the space. Other works that tested foraging devices as enrichment (e. g., Celli *et al*., 2003; Lessa, 2009; Westergaard & Fragaszy, 1985) achieved results similar to those in our study. It suggests that interventions of this kind could also intensify the manipulative behavior of captive primates.

Another likely benefit from the enrichment is the reduction (although not significant) of the agonistic interactions to most of the monkeys, notably during the Verification phase. In fact, the environmental enrichment techniques have great potential to reduce the number of aggressions in non-human captive primates, thus improving the welfare of individuals involved in aggressions (Honess & Marin, 2006). This also happens with enrichments offered to Capuchin Monkeys (e.g., Lessa, 2009) and other primates (e.g., Boccia & Hijazi, 1998). One exception refers to the work by Jacobsen et al. (2010), with no reduction of agonistic interactions after enrichment. However, the Capuchin Monkeys studied by those authors were old and lived together for a long time. The agonism degree between them could be very low even before the intervention (the authors do not provide these data on the baseline).

The enrichment that we used had no significant effect on the frequency of agonistic interactions in the group. Nonetheless, most of the subjects reduced or kept the low number of agonistic behaviors emitted, at some point after the apparatus was introduced. For the *alpha* male (M1), this reduction was drastic. Theoretically, this can have positive effects on the entire dynamic of the social group (De Waal, 1986). Therefore, despite the lack of a significant effect to the group, the reduction of agonistic behaviors may have contributed to the physical and psychological welfare of some individuals.

We have found no significant effects to any behavioral categories indicative of stress. In other words, despite the increase of manipulative behaviors and lower aggressiveness of the *alpha* male, we cannot affirm that the treatment we used had a positive effect on the welfare of the group as a whole. These results corroborate those of the only previous study involving tools as enrichment for Capuchin Monkeys (Mendonça-Furtado, 2006). Once the apparatus that induce only simple manipulations have been efficient to reduce behaviors and hormones indicative of stress (e.g. Boinski et al., 1999; Lessa, 2009), one could expect that enrichments with tools involving greater challenge and resolution time would be even more efficient. A likely reason for this not to happen in our study is the high behavioral variability among subjects. The Baseline of our study showed great variation not only for the profiles of time budget, but also on the manifestations of behaviors indicative of stress. This is a common situation among zoo animals. Mason (1991), for example, argues that individuals of the same species can execute stereotypies with different degrees of variation, depending on how each animal reacts to stressing factors. Therefore, these are idiosyncratic actions.

An important consequence of the individual differences is that the members of the same social group can have very different reactions to the same stimuli and environmental conditions (Broom & Molento, 2004), including those introduced as enrichment. As such, the same intervention could have very different effects on the members of the same captive group (Broom, 1986). For enrichments involving challenges, the intervention efficiency also depends on the individual's cognitive skill (Pizzutto, Sgai & Guimarães, 2009). For example, difficulties to solve the problem could increase the emergence of abnormal behaviors. Easy tasks, in turn, could reduce the use and effect of the enrichment (Meehan & Mench, 2007). In fact, Leavens, Aureli, Hopkins & Hyatt (2001), in a work with chimpanzees, observed an increase of self-directed actions among some subjects first exposed to an easy task and gradually increasing its degree of difficulty. Lessa (2009) in turn, succeeded in reducing the behavior of roaming among Capuchin Monkeys. To that, he introduced a challenge that, despite consuming time to be solved, was relatively simple. All subjects have successfully used it.

As we could observe, the percentage use of the enrichment apparatus and the hit rates in this use widely varied between subjects in our study. This could have contributed to increase some individual behaviors indicative of stress. For example, female F2 made low use of the apparatus (3.61%). However, her hit rate was relatively high (60%). This suggests it may have lost interest for the apparatus because of the easiness in solving the problem. This could explain the inconsistency of the effect of the apparatus to this female. On the other hand, the male M1 showed more stress behaviors after the introduction of the apparatus. The time spent by this male using the apparatus (7.71%) and its hit rate (19.79%) were median and low, respectively. The hit rate was the lowest among all monkeys. Here, we could suppose that cognitive skills in relation to the apparatus were below the required to quickly solve the task. This could have generated stress, rather than reduce it.

It is worth adding that, in general, the behaviors indicative of stress dropped at some point after the introduction of the enriching apparatus for those subjects that presented it more on the Baseline. For self-directed behaviors, there was a remarkable reduction for the three individuals that presented a large number of these on the Baseline (F1, F3 and F4, notably this last) and substantial increase for female F2. Likewise, "Pacing" and "Stereotyped Behaviors" were less expressed by F2 and F1, respectively. Male M1, however, increased the execution of these two actions after the introduction of

the apparatus. Finally, the male M1 - which presented the highest rate of agonism on the Baseline - showed considerable reduction in its aggressions against the remainder subjects in the following conditions.

Conclusions

The environmental enrichment used in this study promoted increased time spent with manipulation of objects, stimulating the cognition and thus raising the behavioral variability of subjects. One could also argue that the enrichment used has positively influenced the social dynamic of the group, because it reduced the frequency of agonistic behaviors. Considering that these results can be achieved using simpler (and less expensive) apparatuses, one can challenge the use of induced tool use apparatus - typically more complex - as an advantageous alternative to promote the welfare of captive groups. In fact, the environmental enrichment technique used was not efficacious to reduce the behaviors indicative of stress in the group of subjects of our study. This could be explained by the individual differences in the group, that led the individuals to react in different ways to the intervention proposed. The individual variability is likely to be very common in zoos, because groups of captive Capuchin Monkeys are typically composed by individuals of different origins (and, therefore, genotypes) and backgrounds in and out that place. As such, the apparatuses that induce tools could have little consistent effects on most of the captive groups of Capuchin Monkeys.

Although the enrichment practice used had generated no global effect, it promoted some positive effects to some individuals. This way, we suggest that, although being insufficient to our study group, the apparatuses that induce tools use could have positive effects when the main targets are specific subjects or groups exposed to very stressing conditions. Moreover, we cannot disregard the possibility that other types of apparatus that induce tools use could have a more homogeneous effect on the group, isolated or as part of programs involving different enrichments.

New studies about cognitive enrichments in primates are required due to their theoretical and practical relevance, both in the light of species studied and in the light of comparison with the human being. Finally, the use of tools raised the visitors' interested. This interest may build empathic feelings towards the monkey and is likely to raise favorable attitudes in relation to the animals and the environment.

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