Environmental Enrichment Objects for the Improvement of Locomotion of Caged Rhesus Macaques (*Macaca mulatta*)

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Introduction and Literature

Environmental enrichment in general is a major issue of debate in laboratory animal science. It is part of the refinement of housing conditions recommended by the “3R”-concept of Russell and Burch (1959) for the improvement of animal experimentation, contributing significantly to the well-being of laboratory animals.

This issue is of extraordinary importance in primates, because of their high cognitive abilities in comparison to other laboratory animals (Bayne, 1991; for specific examples see Bloom & Cook, 1989; Buchanan-Smith, 1995; Lutz & Novak, 1995; Line & Hougton, 1987; Line et al., 1989; Markowitz & Line, 1989; Meunier et al., 1989; Murchison, 1991; Preilowski et al. 1988; Reinhardt, 1990, 1992, 1993, 2003; Reinhardt et. al., 1989; and Reinhardt & Reinhardt, 2003). To avoid behavioral abnormalities in these species, it is essential to supply cognitive challenges in the form of different environmental enrichment procedures regularly (Line, 1987).

The aim of this study was to examine whether the locomotion of caged rhesus macaques at the Paul-Ehrlich-Institut is reduced compared to rhesus macaques in their natural environment. Second, we investigated whether locomotion of caged rhesus macaques can be improved by using two locomotive objects: a treadmill and a rotary barrel.

Materials and methods

Animals: The study was conducted with two groups of Chinese rhesus macaques, described in Table 1, at the Paul-Ehrlich-Institut (PEI) in Langen, Germany. Some were imported; the others born here.

Housing: The groups of monkeys were housed in an indoor primate facility in two closed, tiled, and air conditioned rooms. The cages were stainless steel, 3 x 1.25 x 2.25 meters (8.44 m³). Temperature was controlled at 20°C, and humidity was between 40 and 60 percent. A twelve-hour day was automatically started at 6:00 a.m. with artificial neon light. Natural daylight came through one window. Feeding consisted of monkey pellets (“ssniff Primaten, vegetarisch”, 10 mm; @ssniff Spezialitäten GmbH, Soest, Germany) ad libitum between 8:00 and 9:00 a.m., and a variety of seasonal vegetables and fruits between 12.30 and 13.30 p.m.

In each cage, the following objects were available: three metal benches, two metal rods, a hanging Primahedron swing, and three branches. In addition, plastic bottles, plastic canisters, rubber balls, and cartons were supplied at irregular intervals.

<table>
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<th>Age</th>
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<td>China</td>
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Table 1: Description of the two study groups

Enrichment objects: A metal treadmill 78 cm in diameter (Figure 1) and a rotating wooden barrel (vol. = 30 liters, Figure 2) were used. Each group received the treadmill first and the barrel later.

Figure 1: A metal treadmill.

Collection of data: First, the animals were trained for half a year, until they accepted the presence of an observer in the animal room without any change in behavior. During this time, any kind of behavior was recorded.
After this, a time budget was recorded for the time between 6:00 a.m. and 6:00 p.m., in order to compare these data with those of rhesus monkeys in their natural environment. For this purpose, one minute was used to detect the actual behavior of each individual within a group (i.e., 10/12 seconds for each individual). The observed behavior was placed in one of the six following categories: feeding, locomotion, resting, social behavior, agonistic behavior, and other behaviors.

Figure 2: A rotating wooden barrel.

For calculating the effectiveness of the treadmill and barrel, data were collected for two hours per day (10:00 a.m.-12:00 a.m.) as described in the above section. There were two control weeks before the treadmill was offered Tuesday through Friday for two weeks; then two additional control weeks. This was followed by four weeks of “discontinuous object-offer” (only Tuesdays and Fridays), and another two control weeks (Figure 3). This schedule was then repeated for the barrel.

Figure 3: Study design for each of the two objects

Data calculation: First, median values were calculated for all animals and all categories. With these values, a time budget was produced. For statistical calculation, the Wilcoxon Rank Sum Test, Wilcoxon Signed Rank Test, Friedman Test, and Bonferroni-Holm adjusted Wilcoxon-Signed Rank Test were used where appropriate.

Results

Chopra, Seth & Seth (1992) published time budgets of rhesus macaques living at different places in India. In comparison to these behavioral data, especially rhesus macaques living in areas categorized by the authors as “temple” and “street”, our two groups of caged rhesus macaques at the PEI spent an equal amount of time in locomotion (Figure 4).

![Figure 4](image)

Figure 4: Amount of locomotion (in % of time) observed in rhesus macaques in India and at the Paul-Ehrlich-Institut.

Both the treadmill and rotating barrel were used for locomotion by both groups of caged rhesus macaques (Table 2). Juveniles within both groups used the objects significantly more often than the adults (Wilcoxon Rank Sum Test, one-sided hypothesis, $\alpha=0.025$, $p<0.0001$; Table 2).

<table>
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<th>Group A</th>
<th>Group B</th>
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<tbody>
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<td>barrel</td>
<td>2.9% 0.8% 1.4% 16.5% 19.7% 16.3%</td>
<td>0.5% 1.9% 0.1% 11.0% 23.2%</td>
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<tr>
<td>treadmill</td>
<td>0.2% 0.2% 0.1% 12.2% 13.0% 14.0%</td>
<td>0.5% 0.5% 2.1% 17.9% 29.6%</td>
</tr>
<tr>
<td>Animal number</td>
<td>59 53 58 287 303 272</td>
<td>238 54 265 284 307</td>
</tr>
</tbody>
</table>

Table 2: Mean percentage of time which the monkeys spent with the objects. See Table 1 for animal descriptions.

The total amount of locomotion in both groups was significantly increased while the objects were present, compared to the control weeks (Friedman-Test, $p=0.0001$; Figure 5; locomotion with and without objects).

There was no significant difference in the use of either the barrel or the treadmill between the groups (Bonferroni-Holm adjusted Wilcoxon-Signed Rank Test, one-sided hypothesis, $\alpha=0.025$, $p=0.047$; Figure 6). However, individual preferences could be demonstrated (data not shown).

No significant differences were detected between a “continuous” supply of the objects (4 consecutive times per week for two weeks) and a discontinuous supply (2 nonconsecutive days a week for four weeks) (Wilcoxon
Signed Rank Test, one-sided hypothesis, $\alpha=0.025$, $p=0.0423$; Figure 6).

In addition, no loss of interest in either object within the period of investigation could be demonstrated for the whole group (Figure 6); however, individual differences were seen (data not shown).

Due to the increase in locomotion, the amount of time spent in aggressive behavior significantly decreased (Wilcoxon Signed Rank Test, one-sided hypothesis, $\alpha=0.025$, $p<0.0001$; result: minus 0.7% / minus 0.8%, respectively).

Discussion

The hypothesis of the present study was that, due to the restricted amount of space, the caged monkeys necessarily move less than those in a natural habitat with its foraging necessity.

However, the time budget in the laboratory, compared to that described by Chopra et al. (1992), showed that, even in nature, especially in areas where the monkeys have not been encouraged to forage much for food, the amount of locomotion was comparable to what we found in our caged groups. Of course, one needs to be very careful in comparing literature data with one’s own results, since many factors can contribute to differences. Nevertheless, the relative equality in locomotion was an unexpected result of our first data collection.

On the other hand, it was not surprising that our groups of rhesus macaques used both locomotion objects within their cages. However, the difference in object use between the adults and the juveniles was unexpectedly high: while the adults almost did not use the objects at all, the youngsters spent up to nearly 30% of their time with one of them (the treadmill). The greater amount of curiosity in younger individuals might have contributed to this result. We have seen similar results when we offered other objects, such as puzzle feeders, to vervets.

Although a barrel may be used differently from a metal treadmill (e.g., chewing on the wooden barrel components), we were unable to detect significant differences in the use of either the rotating wooden barrel or the metal treadmill at the group level. However, as mentioned in “Results”, individual preferences for one or the other were seen during the investigation.

Although we were unable to detect any significant differences between a continuous or discontinuous offer of a locomotion object, we would recommend a discontinuous offer, since this allows the provision of another object on the other days, and therefore the opportunity for more variation in housing conditions.

At the group level, we were unable to demonstrate any loss of interest within the period of investigation. However, this period might be too short to answer a question of steady interest sufficiently, since we are housing monkeys with a life span of more than 30 years.

By offering the objects we were able to increase the amount of locomotion significantly compared to the control weeks. This effect simultaneously decreased the amount of agonistic behavior. This is, of course, a desired effect for a colony of caged rhesus macaques.
positive is the simultaneous reduction in social interactions within the groups when the objects are present. The question is, whether these reductions stay stable when the objects are offered for a longer period of time.

References

Bayne, K. (1991). Providing environmental enrichment objects are offered for a longer period of time. The question is, whether these reductions stay stable when the objects are present in the groups when the objects are present. The question is, whether these reductions stay stable when the objects are offered for a longer period of time.


ASP 2006 Conservation Small Grant Applications

The American Society of Primatologists’ Conservation Committee is soliciting grant proposals for ASP Conservation Small Grants for 2006. These grants (up to $1,500) are designed to help fund conservation research or related projects, including conservation education. ASP members working in habitat countries are especially urged to apply or to help someone from a habitat country submit a meaningful project which can be a portion of a larger effort. Grant application guidelines may be obtained by contacting the ASP Conservation Committee Chair at the address below or at the ASP Website.

The ASP Conservation Committee will be making the Conservation Small Grant awards early again this year. This decision was made to better facilitate our getting conservation grant money to the winners in time for the “summer” months – when many of these projects get underway. The 2006 deadline for submission of grant proposals is January 16, 2006. Materials may be submitted online at the ASP Website, <www.asp.org>, beginning in early December, or sent as an e-mail attachment to the Committee Chair. Grants will be announced in late March. Please direct any questions to: Janette Wallis, Chair, ASP Conservation Committee, ABT1-American Univ. of Nigeria, Lamido Zubairu Way, Yola Township By-pass, PMB 2250, Yola, Adamawa, Nigeria [e-mail: janettewallis@sbcglobal.net or jwallis@aaun.edu.ng].