Journal of the American Association for Laboratory Animal Science
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Vol 53, No 6
November 2014
Pages 653–656

Using Porches to Decrease Feces Painting in Rhesus Macaques (*Macaca mulatta*)

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The goal of this project was to evaluate the efficacy of a porch in decreasing feces painting in captive rhesus macaques. The porch is a small extension that is hung on the outside of a monkey's primary home cage. Porches provide many potential benefits to indoor-housed macaques, including opportunities to perch above the ground, additional space, and increased field of view. Rates of feces painting, an abnormal behavior in which the animal smears or rubs feces on a surface, were compared in 3 situations: with porch enrichment, with 'smear board' enrichment (a foraging device commonly used to decrease feces painting), and without either enrichment item. Feces painting was evaluated daily by using a 5-point scale that ranged from 0, no feces present, to 4, multiple large areas of feces. We found that subjects received significantly lower feces painting scores when given porch enrichment or smear board enrichment compared with baseline. Furthermore, subjects received significantly lower feces painting scores with porch enrichment than smear board enrichment. These results demonstrate that the porch is an effective tool to decrease feces painting in captive macaques.

In captivity, nonhuman primates often develop abnormal behaviors—behaviors that are statistically rare in wild populations[16]—such as self-directed behaviors (for example, self-bite), stereotypic behaviors (for example, repetitive pacing), and appetite disorders (for example, coprophagy).[8] Behavioral managers, veterinarians, and animal caretakers go to great lengths to decrease the occurrence of these behaviors. One abnormal behavior seen in nonhuman primates, feces painting, occurs when an animal smears or rubs feces on a surface, typically the side of the cage. Feces painting goes by many names in the literature, including feces smearing,[8,11] fecal smearing,[7] feces spreading,[6,15] and finger painting.[10] Although the behavior occurs in macaques,[5,20] most accounts of feces painting have been in the great apes.[7,10,12,17] Although the direct cause of feces painting is unknown, it often is postulated to be related to boredom, a lack of socialization, or simply a lack of alternative behavioral opportunities.[8,10,12] Animals that lack sufficient stimulation are likely to shift their attention to whatever is available within their cage. Because feces are one of the few items available that can be manipulated, some animals begin touching, smearing, and even eating their feces as a form of stimulation. Unlike some abnormal behaviors, such as self-abusive behaviors, the act of feces painting is not believed to be indicative of underlying animal pain or distress. However, because feces on cage walls are unsanitary and difficult to clean, the behavior is a health concern to veterinarians and a frequent complaint of animal caretakers. Surprisingly, there are few published records of rates of feces painting in rhesus macaques.

Although there is a paucity of information regarding methods for decreasing feces painting in primates, there is some evidence that increasing foraging opportunities may be an effective behavioral therapy.[6,17,20] In particular, foraging items that can be spread are often used (for example, peanut butter, honey, edible paint), with the idea that the animals will transfer the smearing behavior from their own feces to this malleable substance. Such items are often provided on a tray or board that is hung from the outside of the cage to allow easy accessibility to caretakers. However, such items increase the daily caloric intake for animals and therefore often cannot be used on a daily basis.

Alternatively, multisensory enrichment such as videos, radio, mirrors, and structural enrichment[3,15] provides stimulation without increasing calories consumed. Given that feces painting is believed to be related to boredom and not to a specific desire to forage, daily exposure to stimulating nonfood-related enrichment might be a more efficacious environmental intervention than are current foraging devices. We evaluated whether a porch, a small cage hung on the outside of an animal's primary home cage, helped to decrease feces painting in rhesus macaques.

Porches extend the cage, slightly increasing the usable cage floor space while providing opportunities for animals to perch above ground level, a behavior that is essential to the wellbeing of most nonhuman primates.[19] In addition, when sitting in the porch, animals can see areas of their home room that are otherwise obscured, providing new opportunities for visual stimulation in their environment. Simply providing nonhuman primates a stimulating environment outside their home cage can increase animal activity and decrease undesirable behaviors, such as self-aggression.[21] Porches provide visual stimulation by allowing nonhuman primates to view and interact with animals they cannot otherwise see and to observe the activities of animal care staff working in the room.

At the Oregon National Primate Research Center (ONPRC), we have used porches as an enrichment item for approximately 8 y. In this time, we have observed that animals spend approximately one-third of their daytime hours using the porch. To evaluate the hypothesis that porches are more effective in decreasing feces painting than is foraging enrichment, we compared the levels of feces painting exhibited by rhesus macaques when they were given a porch with that when they were provided with a 'smear board' or were housed in standard conditions.

Received: 05 Nov 2013. Revision requested: 06 Dec 2013. Accepted: 25 Apr 2014.
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Materials and Methods

Subjects. The subjects for this study were 8 (6 female and 2 male) adult rhesus macaques (*Macaca mulatta*) with no previous exposure to porch enrichment. Subjects were housed in separate rooms that contained 16 to 44 conspecifics at the Oregon National Primate Research Center (Beaverton, OR). All subjects were singly housed for reasons unrelated to the current study in cages with 3.4 to 8.0 ft^2 of floor space and a height of 30 to 36 inches. The mean age of the subjects was 9 y, with a range of 6.2 to 11.7 y. Subjects were selected for the study if they had an established history of feces painting as reported by the animal care staff. Macaques were fed standard monkey chow twice daily and were given fresh produce or other food enrichment daily. Standard enrichment such as chew toys, foraging manipulanda, television, and radio were provided on a regular basis throughout the study. Water was provided freely through automatic lixit systems. All subjects were cared for in compliance with protocols approved by the IACUC and participated in the facility's behavioral management plan. The animal care program adheres to the requirements of the Animal Welfare Act Regulations[1] and is accredited by AAALAC.

Experimental design and data collection. In this study, we assessed feces painting in 3 conditions: with a porch, with a smear board (a foraging device), and without access to either the porch or smear board. The porches (Carter$_2$ Systems; http://www.carter2systems.com/) were cage extensions (11 in. × 19 in. × 15 in.) made of stainless steel, which attached to the door opening of the animal's home cage and were strong and secure enough to support the weight of a macaque (Figure 1). Smear boards were polycarbonate plastic panels (2.5 in. × 5 in.) with multiple holes. Boards were covered with approximately 2 tablespoons of peanut butter before being attached to the front of an animal's cage (Figure 2).

Throughout the study, a trained observer assessed the amount of feces present on the sides of the cages by using a 'feces painting score'. The score was based on a 5-point scale: 0, no feces present; 1, a single small area of feces present; 2, multiple small or a single moderately sized area of feces present; 3, multiple moderately sized areas of feces present or one large area of feces present; and 4, multiple large areas of feces present. Observations were conducted daily between 0730 and 0830, before cages were washed.

All subjects underwent 5 conditions: baseline, treatment 1, posttreatment 1, treatment 2, and posttreatment 2. Subjects received standard enrichment (for example, toys, foraging manipulanda, television, and radio) during all conditions. During the treatment conditions, the animals received either a porch or smear-board in addition to the standard enrichment. Both enrichment devices remained on the front of the cage continuously for the duration of the condition. The smear board was covered with peanut butter 3 times each week. We included the postenrichment conditions to determine whether animals regressed to baseline levels of feces painting after the enrichment was removed or whether they maintained any potential benefit from the previous enrichment.

All subjects were randomly assigned to 1 of 2 groups (A or B), each of which consisted of one male and 3 female macaques. For group A, treatment 1 was the porch and treatment 2 was the smear board, whereas for group B the treatments were reversed. Our goal was to study each condition for approximately 3 wk. However, after the first enrichment phase, we discovered that some of the animals were scheduled to be moved to other areas that precluded use of the porch; we therefore shortened the remaining phases of the study. This discrepancy in time was accounted for in the statistical analyses. Figure 3 details the order and duration of the various conditions.

Figure 1. A rhesus macaque sitting in the porch enrichment.

Figure 2. A rhesus macaque using the smear board enrichment.

Statistical analysis. Data were analyzed by using generalized linear mixed effects modeling using R computational software.[18] Data were analyzed under the assumption that the underlying response follows a Poisson distribution. In the first analysis, condition (baseline compared with porch, smear board, postporch, and postsmear board) was included as the predictor variable, feces painting score as the outcome variable, and both individual animal and group (A compared with B) as random effects. Analysis was performed with 'baseline' as the referent variable so that results would reflect the effects of enrichment and postenrichment conditions compared with baseline.

A second analysis was performed to evaluate the difference in feces painting when macaques received a porch compared with a smear board. Data were analyzed by using only fecal painting scores from observations during enrichment 1 and enrichment 2 phases (Figure 3). Data were analyzed with condition (porch compared with smear board) as the main effect, feces painting score as the outcome, and both individual animal and group (A compared with B) as random effects. To account for the fact that each group received the enrichments in a different order, initial analyses included order of enrichment (first compared with second) as both a main effect and as an interaction with condition. Initial analyses found that order and the interaction between

Study Phase	Days Observed	Group A Condition	Group B Condition
Baseline	22 d	Baseline	Baseline
Enrichment 1	21 d	Porch	Smear board
Post Enrichment 1	10 d	Post-porch	Post-smear board
Enrichment 2	15 d	Smear board	Porch
Post Enrichment 2	8 d	Post-smear board	Post-porch

Figure 3. Schedule of study conditions for groups A and B.

order and condition were nonsignificant (that is, $P > 0.05$), and subsequent analyses included order only as a random effect.

The smear board was covered with peanut butter only 3 times each week. To evaluate whether animals displayed less feces painting on days in which the boards were newly covered with peanut butter, data from the smear board treatment were analyzed with a yes–no variable indicating whether or not the device was covered with peanut butter on the previous day as the main effect, feces painting score as the outcome, and both individual animal and group (A compared with B) as random effects.

Results

During the baseline period, the average feces painting score in our rhesus macaques was 1.97 ± 0.12. Although the sample size is too low for statistical comparisons, male and female macaques had similar average baseline scores (female, 2.05; male, 1.72).

Compared with baseline, subjects received significantly lower feces painting scores when given the porch enrichment (average score, 0.94; $\beta = -0.76$; $P < 0.001$) or the smear board enrichment (average feces painting score, 1.56; $\beta = -0.21$; $P < 0.05$; Figure 4). On average, subjects' feces painting scores decreased by 52% with a porch and 21% with a smear board, compared with baseline. Furthermore, subjects received significantly ($\beta = -0.57$, $P < 0.001$) lower scores with the porch compared with the smear board, with subjects' feces painting scores on average 40% lower with a porch than a smear board (Figure 4).

The observed decrease in feces painting with porch and smear board persisted after the devices were removed; subjects engaged in less feces painting postporch (average feces painting score = 1.21, $\beta = -0.50$, $P < 0.001$) and postsmear board (average feces painting score = 1.23, $\beta = -0.42$, $P < 0.001$) compared with baseline (Figure 4). On average, subjects' feces painting scores after exposure to both the porch and smear board were 39% and 38% lower than baseline, respectively.

Time since peanut butter had been applied to the smear board did not affect feces painting by rhesus macaques in this study. Feces painting scores recorded the day after the boards were covered with peanut butter were not significantly different ($P = 0.63$) from those recorded 2 or 3 d after application.

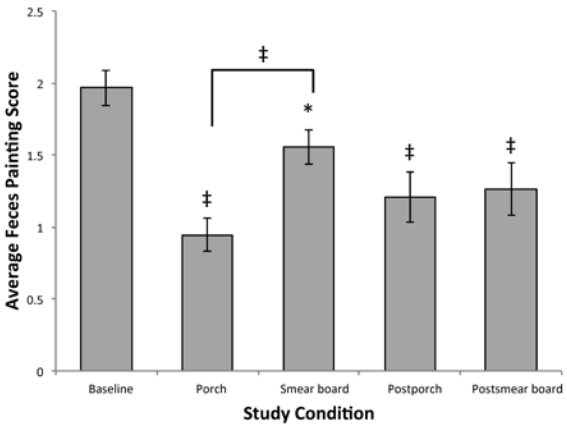

Figure 4. Effect of porch and smear board enrichment on feces painting. Average feces painting score for monkeys in various study conditions. Experimental conditions (porch, postporch, smear board, and postsmear board) are all compared with baseline levels of feces painting, and porch condition is in addition compared with smear board. Value significantly (*, $P < 0.05$; ‡, $P < 0.001$) different from baseline.

Discussion

Feces painting by nonhuman primates is unsanitary, and the resulting feces on the walls of cages requires a large amount of work by animal care staff to remove. Thus, feces painting is highly undesirable from a management perspective. It can affect a large number of primates in captivity; at our facility, as many as 4% (approximately 50 to 60 individuals) of indoor-housed animals are reported to regularly engage in feces painting at any given time. To date, few studies have examined methods to decrease this behavior in rhesus macaques. We found that porches, a modification to the standard monkey cage, are an effective strategy for decreasing feces painting. On average, subjects' scores decreased by more than 50% when they had access to a porch compared with baseline conditions. In addition, feces painting decreased by an average of 21% relative to baseline when subjects received foraging smear boards, supporting previous reports that foraging enrichment can decrease this behavior.[6,17,20]

Although the smear boards remained on the cages 7 d a week, fresh peanut butter was applied only on 3 d (Mondays, Wednesdays, and Fridays). Surprisingly, feces painting did not differ between days on which the peanut butter was freshly reapplied and those on which it was not, indicating that the smear boards were equally efficacious on all days of the week. Because some peanut butter may have remained in the holes a day or so after application, increasing the interval between applications may have produced different results. It is also possible that simply having the opportunity to forage and smear peanut butter 3 d a week was sufficiently beneficial to create lasting changes in feces smearing. Regardless, these results indicate that covering the smear boards with peanut butter 3 d each week was an effective treatment for feces painting.

Unlike smear boards, which provide a single form of stimulation that could eventually be consumed, porches can provide multisensory stimulation. Porches afford animals the opportunity to perch above the ground, physical space for locomotion, and, potentially most important, increased range of vision in the room. As expected, porches were significantly more effective in decreasing feces painting than was smear board enrichment: subjects' scores were, on average, 40% lower with porches than smear boards.

Nonhuman primates are believed to engage in feces painting due in part to a lack of alternative forms of stimulation. We speculate that porches decreased feces painting by providing animals with increased visible stimuli outside their home cage. Compared with sitting in the primary cage, macaques sitting in

the porch can see a larger portion of the animal room, providing opportunities to view and interact with caged animals that are otherwise out of sight. Socialization is extremely important for the welfare of captive primates,[2,9,14] and by increasing animals' field of view, porches can provide new opportunities for visual-based social behaviors such as lipsmacking and presenting. Furthermore, porches can allow nonhuman primates to see most of the husbandry activity occurring at any given time. Many husbandry events, such as room cleaning, health checks, and daily feedings, can be perceived as stressful to captive nonhuman primates.[13] These activities may be particularly stressful if animals are unsure which events are about to occur.[4] When using the porch, macaques are able to view most husbandry activities and locate the source of unexpected adverse noises, potentially providing a valuable sense of understanding over an otherwise unpredictable environment. Depending on the aversiveness of these activities, monkeys can remain on the porch or retreat to the back of the cage, providing the animals choice and control.

Although we speculate that subjects decreased feces painting when given a porch because of the additional opportunities for stimulation, it is also possible that the behavior decreased in part because the macaques were physically unable to smear feces on a cage wall while sitting in a porch. Therefore, porches may lead to a decrease in feces painting simply by promoting an incompatible behavior. Still, it is important to recognize that if feces painting decreased due to incompatible porch usage, then the monkeys actively chose to use the porch instead of to engage in feces painting. Because feces painting is thought to be self-stimulating,[10,12] the act of choosing to use the porch instead of painting may indicate that the porch is somewhat stimulating to the animal. Furthermore, it is unlikely incompatible behaviors were the only factors involved, as incompatible behaviors alone cannot explain the residual decrease in painting after the porch was removed.

One limitation of the present study was that we only assessed feces painting scores and did not examine other behavioral measures. Thus, we do not know whether indicators of stress (for example, displacement behaviors, stereotypic behaviors) were affected by the use of the porch. Facility animal care staff reported anecdotally that the subjects spent considerable amounts of time in the porch, but additional research is needed to examine the effectiveness of the porch as a tool to improve psychologic wellbeing. Regardless of the underlying cause, this study demonstrated that both porches and foraging enrichment are effective tools for decreasing feces painting, an abnormal behavior in nonhuman primates that has undesirable health and husbandry outcomes. Porches were particularly beneficial because they did not increase animals' daily caloric intake and yet still led to a greater decrease in feces painting than did traditional foraging enrichment alone.

Acknowledgments

We thank Sarah Guinther and Melena Codekas for their assistance in data collection, Andrea Gottlieb for her help in data analysis, the Oregon National Primate Research Center Division of Comparative Medicine for help and support of this project, and Carter Systems for making the porch. This project was supported by NIH 8P51OD011092.

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