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Evaluating Paint Rollers as an Intervention for Alopecia in Monkeys in the Laboratory (*Macaca nemestrina*)

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Abstract

Adult female macaques (*Macaca nemestrina*) in the laboratory with alopecia from known or suspected overgrooming were subjects in a study evaluating effectiveness of a grooming device. The intervention evaluated was a paint roller on a metal bar hung on the cage, replaced weekly for 6 weeks. In a within-subjects design, 6 monkeys were randomly assigned to first experience the paint roller (PR) and later the control (C) condition (roller bar only); 6 monkeys were randomly assigned to C followed by PR. Coat condition scores quantifying alopecia were taken cageside weekly. During PR, PR use was scored 3 times a week based on wear. Alopecia scores during PR did not differ significantly from C. Although all the monkeys used the paint rollers, PR use scores did not correlate significantly with improvement in coat condition. Paint rollers do not appear to be an effective intervention for alopecia from overgrooming.

Stereotypies and other abnormal behaviors in nonhuman animal subjects in the laboratory may have negative impacts on scientific outcomes (Garner, 2005). In nonhuman primates, the display of concerning abnormal behaviors and physical signs suggesting compromised well being are indicators of potentially poor research candidates (Bellanca & Crockett, 2002). Among these, alopecia has received increasing regulatory scrutiny, perhaps because it is a continuously visible characteristic (Baker, Crockett, Bloomsmith, Coleman, & Bellanca, 2006). Alopecia in nonhuman primates may result from behavioral factors such as overgrooming (self-plucking and related behaviors) or a variety of nonbehavioral factors including seasonal changes, aging, nutritional deficits, hormonal imbalances, genotype, and infections (Novak & Meyer, 2009). Clinical veterinarians address alopecia of presumed medical etiologies such as dermatitis whereas behavioral staff focus on psychological etiologies.

A foraging/grooming board designed as an intervention did result in reductions in abnormal behaviors and increased grooming and foraging behaviors in a study of eight rhesus macaques (*Macaca mulatta*; Bayne et al., 1991). The device was a fleece-covered board sprinkled with fruit-flavored food particles daily. Although the investigators considered self-plucking an abnormal behavior, it was combined with other behaviors into a larger category (self-directed behavior) and alopecia was not scored. Tully, Jenne, and Coleman (2002)

provided grooming boards or paint rollers hung outside the cage and covered in a mixture of crackers and honey to rhesus macaques (*Macaca mulatta*) in the hope that overgrooming behavior would decrease. After 6 weeks, no significant difference was found in alopecia between the six paint-roller, six grooming-board, and six control subjects.

At the Washington National Primate Research Center (WaNPRC), the Psychological Well-being (PWB) Program uses paint rollers hung on a stainless-steel rod affixed to the outside of laboratory monkey cages as special enrichment for overgrooming, particularly when the more obvious enrichment, a social partner, is not allowed by research protocol. PWB staff reason that providing a device that encourages redirected grooming behavior might reduce overgrooming behavior. Food is not added to the paint roller so as not to confound grooming behavior with foraging behavior. Paint rollers are discarded after use, thereby avoiding time-consuming sanitizing procedures required of expensive grooming-board devices. The stainless-steel rods (roller bars) are indestructible and easily sanitized in the cage washer.

In 2006, PWB staff scored alopecia in all 637 monkeys at the WaNPRC facility using a simple four-category system (0 = none, 1 = mild, 2 = moderate, 3 = severe) and found *M. nemestrina* to have significantly higher alopecia scores than *M. mulatta* or *M. fascicularis*, but no sex differences emerged (Crockett, Bentson, & Bellanca, 2007). The present study evaluated the effectiveness of the paint rollers in reducing alopecia in adult female pigtailed macaques, *M. nemestrina*, selected on the basis of having alopecia from known or suspected overgrooming. A detailed scoring system for recording alopecia by body part was developed, and paint-roller use was scored based on roller appearance.

METHOD

Study Animals

Fourteen female pigtailed macaques (*Macaca nemestrina*) housed at the WaNPRC were subjects in the investigation. The subjects selected had alopecia resulting from confirmed or suspected overgrooming and were being monitored by PWB staff. The monkeys ranged in age from 4.5 to 16.5 years at the time of selection. Thirteen of the subjects participated in the initial phase, 7 having been randomly assigned to the experimental condition (Paint Roller; PR) and 6 to the control condition (C). In the second phase, those in the previous PR condition were placed in the C condition, and vice versa. One PR subject from Phase 1 was unable to participate as a control during Phase 2. A 14th subject participated in the PR condition in Phase 2, selected on the basis of having a similar body coat condition. In total, 12 subjects experienced both PR and C conditions, and 14 participated only in PR.

All subjects were housed in the same room containing only female *M. nemestrina*, the number ranging from 30 to 34 over the data collection period. The room was kept on a 12-hr light–12-hr dark cycle at an average temperature of about 23°C. The monkeys were housed in stainless-steel cages of sizes appropriate for their weight, as specified by the Animal Welfare Regulations (U.S. Department of Agriculture, 1991). All were assigned to the same investigator on research projects approved by the University of Washington Institutional Animal Care and Use Committee. They experienced similar procedures involving sedations

and single housing and, with the exception of physical social contact, received enrichment according to the Environmental Enhancement Plan.

Data Collection Scoring Systems

During the experimental (PR) condition, a paint roller was hung on a detachable roller bar on the outside of the monkeys' cages; during the control (C) condition, only the roller bar was on the cage. The monkeys were scored once every week on the severity of alopecia. The scoring order was randomly determined for each day. The investigator scored the extent of paint-roller use three times per week during 6 weeks of PR presence.

Scales for scoring coat condition and paint-roller use were implemented in this investigation. Instead of the 0–3 scale used by PWB staff to score alopecia (Crockett et al., 2007), the first author (E.R.) developed a new scoring system to include a wider range of possible scores and to enable a straightforward method of producing whole-body alopecia ratings from individual body section scores. The 12 body sections were as follows: head, shoulders, dorsal torso (back), ventral torso (chest and stomach), ventral (inner surface) and dorsal (outer surface) of left and right forelimbs, and ventral and dorsal left and right hindlimbs (Figure 1). A body map previously developed for measuring coat barbering in mice provided an intuitive and simple model for segregating the body into parts and served as the basis for this method (Garner, Weisker, Dufour, & Mench, 2004).

The body sections were then assigned weights roughly corresponding to their relative surface areas (Figure 1). During weekly scoring sessions, each body section was scored individually on the alopecia scale. An Excel spreadsheet later multiplied section scores by their corresponding weights and summed them to produce a total-body alopecia rating ranging from 0 to 1.0. This method accommodated both the need for a total-body score and the need for producing a quantitative measure of alopecia. When body areas could not be seen, weights were adjusted as explained later.

Each body section received a score from 0 to 1.0: 0 = no observable alopecia; 0.2 = slight/mild alopecia or a small bare patch; 0.4 = moderate-mild alopecia or several small bare patches covering <50% of the section's surface; 0.6 = moderate-severe alopecia or several small bare patches or large bare patches covering 50%; 0.8 = severe alopecia and/or a surface nearly covered by bare patches; 1.0 = the skin in a section was completely devoid of hair.

When it was impossible to assign scores to particular body sections because the monkey would not present those surfaces during observations, the surface was scored as "unknown." To correct for this during computation of total-body scores, the weight of the missing body section was divided by the number of scored body sections. The resulting number was then added to each remaining body section weight to produce a modified weighting factor. For example, if a body section weighted 0.1 could not be scored, then 0.1/11 (for 11 remaining body sections) = .009 was added to the weights of each remaining body part.

The PR use scale was adapted from a preexisting ordinal scale used by PWB to score different degrees of PR degradation or shredding: 1 = no evidence that a monkey used or

manipulated PR (e.g., no biscuit crumb residue or broken fibers; Figure 2, top); 2 = PR had been touched but without significant shredding or residue; 3 = PR was somewhat shredded and/or partly removed from the cardboard tube or bar; 4 = PR was completely or almost completely shredded (Figure 2, bottom) and/or removed from the bar (but parts still present in the cage or on the floor). If the PR or remnants were missing from the hanging bar, and not seen within the room, PR use could not be scored because the reason for its absence was unknown.

Procedure

All observations and paint-roller changes were made by a single observer (E.R.), who was familiar with most of the monkeys based on earlier feeding interactions (e.g., provisioning puzzle balls; Crockett, Bellanca, Heffernan, Ronan, & Bonn, 2001). The 1st week of the experiment (Week 0) was dedicated to collecting baseline coat condition scores using the coat condition scale. The following week, roller bars were attached on the cages of all subjects, and the experimental group received PR hung on their roller bars (Figure 2). The bars were stainless-steel pipe (10 in. [25.4 cm] long $\times$ 1 in. [2.54 cm] diameter) hung by 3 in. (7.62 cm) of stainless-steel chain on 3-in. snap hooks. The paint rollers were medium nap with cardboard cores. (PWB avoids plastic cores because of safety concerns, i.e., sharp plastic shards, if broken.) The installation of PR occurred at the beginning of each data collection week. Husbandry staff was asked to move the paint roller to the subject's clean cage after cage wash.

E.R. scored coat conditions weekly, with all individual subjects randomly selected for scoring on 1 of 2 days; E.R. also scored PR use on both of these days. This concluded Week 1. On the 1st day of Week 2, PR were scored for a third time, removed and discarded, and replaced with new PR. On all data collection days, extensive notes described the condition of PR, alopecia-affected areas, and behaviors of interest by any subject such as interactions with PR or hair pulling. The PR replacement and data collection process continued in this manner for a total of 6 weeks each for both first and second phases. The second phase began 7 weeks after the first phase ended.

Statistical Analyses

Alopecia scores for the 12 subjects who experienced both the paint-roller intervention (PR) and control condition (C; roller bar only) were matched, within subjects. The Improvement Score was the total-body coat condition score after 6 weeks of PR or roller bar only exposure subtracted from the beginning score (Week 0); positive scores indicate improvement. To more fully utilize scores taken every week, the slope of the weekly scores was computed; negative slopes indicate improvement. The final alopecia scores for each phase were matched (PR vs. C) for each of the 12 monkeys. These Improvement Scores, slopes, and phase-end alopecia scores were analyzed with Wilcoxon Matched-Pairs tests (Velleman, 1997).

For 14 subjects experiencing the PR intervention, the last scores each week were averaged for an overall average Paint Roller Use score. During weeks when PR was for some reason missing on the final day (mostly routine cage wash days), the last recorded score was used.

Spearman rank correlation tests examined whether the Improvement Scores and the slopes were correlated with Paint Roller Use scores.

Descriptive statistics evaluated the scoring system itself. To determine whether particular body parts were more difficult to score than others, for each body section the total occasions not scored (unknown = “missing”) was divided by the total possible opportunities to score that part. The week-to-week consistency in scores per body part was examined by calculating the proportion of scores that differed by more than 0.2 (i.e., >20%) from the previous score.

RESULTS

For the 12 monkeys experiencing both PR and C conditions, the mean coat condition improvement score over 6 weeks when receiving PR was 0.049 (± 0.14 *SD*) compared with 0.015 (± 0.08 *SD*) during their control (C) condition. This slightly greater mean improvement during the intervention (~5% vs. 1.5%) was not significant (Wilcoxon test, *ns*, $p = .47$). The slopes for both conditions were slightly negative (consistent with improvement) but essentially zero (PR slope mean = -0.0011 (± 0.004 *SD*), C slope mean = -0.0002 (± 0.002 *SD*)) and did not differ significantly (Wilcoxon test, *ns*, $p = .47$). The alopecia scores at the end of the PR condition averaged .21 ($\pm .12$ *SD*, median = .197) versus .23 ($\pm .15$ *SD*, median = .18) at the end of the control condition (Wilcoxon test, *ns*, $p = .73$). In 7 of 12 monkeys, these end-of-phase alopecia scores differed by less than 2.5% between PR and C conditions.

Two additional monkeys experienced the PR condition only. Of the 14 PR monkeys, 13 had a mean paint-roller use score of 2.52 (± 0.63 *SD*, range = 1.25–3.5). The 14th subject never received a score as her paint roller was always missing from the bar during PR use scoring, probably because she tore it off quickly and it was discarded. No significant correlation was found between mean PR use and coat improvement scores (Spearman $r_s = .07$, $p > .50$, two-tailed) or slope (Spearman $r_s = -.07$, $p > .50$, two-tailed). Mean coat improvement scores versus PR use scores are plotted in Figure 3. The animal with, by far, the greatest improvement in coat condition had the lowest paint roller use. If, hypothetically, the 14th subject indeed tore off the PR each week, equivalent to an average use score of 4.0, the correlation with Improvement would have been $r_s = .19$, $p > .50$, still *ns*.

All 14 subjects had some degree of alopecia. The average alopecia score was .31 ($\pm .17$ *SD*, range = .08–.64) at the beginning of Phase 1 and .20 ($\pm .17$ *SD*, range = .07–.48) at the beginning of Phase 2. E.R. or other PWB staff observed 11 of 14 monkeys engaging in overgrooming behavior, sometimes involving eating the plucked hair. For the remaining 3 monkeys, overgrooming was not verified but remained the suspected etiology.

It took about 10 min to complete coat condition scoring per monkey. For both conditions combined, the body areas were seen well enough to be scored an average of 95.6% ($\pm 4.6\%$ *SD*) of the time (range 89.6–100% across 14 subjects). The ventral (inner) surfaces of left and right legs had the highest “missing” scores, both averaging 15% ($\pm 19\%$ *SD*) missing scores per subject. The dorsal left leg averaged 8% ($\pm 16\%$ *SD*) missing scores and the ventral right arm averaged 7% ($\pm 9\%$ *SD*) missing scores. The dorsal left arm averaged 3%

($\pm 6\%$ *SD*) missing scores, and all other areas averaged 0% to 2% missing scores. High week-to-week consistency in scores per body part was found: only 0.56% of scores differed from a previous score by more than 0.2. This reflected both high intraobserver reliability and little or no change in alopecia per monkey's body part on a weekly time scale.

DISCUSSION

The results of this study suggest that the use of paint rollers as standard treatment for overgrooming and alopecia in female pigtailed macaques is not warranted on a population-wide level. Overall, monkeys in the experimental condition did not show coat improvements (or deteriorations) proportionate to the extent that they used the paint roller enrichment. Within the subject pool of 14 monkeys, there was much inconsistency in terms of PR use and associated coat condition change. The subject with the highest average PR use score displayed a slight deterioration in coat condition whereas the subject with the largest overall coat improvement demonstrated little PR use (Figure 3). The slopes of the alopecia scores indicated little change whether or not a monkey was experiencing the PR intervention. The duration of exposure to the paint roller (6 weeks) was sufficient to allow notable regrowth of hair coat had it occurred (Beisner & Isbell, 2009).

Overall, paint roller enrichment appears to have little impact on overgrooming and alopecia. Some individual cases with moderate PR use showed some improvement during the PR phase. Although this could have been coincidental, continued provision of the paint roller to those monkeys might be warranted. The PR use data and behavioral notes indicate that every monkey did use the paint roller to some extent and that it therefore could be considered environmental enrichment for all. However, the observations also suggest that the monkeys did not use the PR as intended. They seldom, if ever, appeared to engage in redirected grooming behavior. Instead, the PR was explored and manipulated, with teeth as well as fingers, and tearing the roller off the bar was the objective of at least some of the monkeys. It also became clear during the data collection process that monkeys did not use the PR in a linear fashion. The PR may have been manipulated thoroughly and destructively for a period of 10 min or used extensively throughout the entire week with the same score recorded at the end of the week. Clearly, these situations do not equate with the same duration of use.

Lutz and Novak (2005) proposed that the effectiveness of environmental enrichment should be evaluated with respect to (1) promoting species typical behavior through (1a) demonstrating usage of the enrichment and (1b) normalizing the behavioral repertoire in general and (2) reducing the occurrence of abnormal behavior through (2a) successful therapeutic intervention and (2b) prevention of development of the abnormal behavior in question. The results of the present study found that the paint roller enrichment was used (1a) but did not involve systematic behavioral data collection so cannot evaluate 1b. Based on the indirect measure of alopecia scores, the PR did not seem to be an effective intervention for overgrooming (2a). Because the subjects were preselected for having alopecia and overgrooming behavior, these results cannot speak to 2b.

The subjects in the paint roller study were not allowed tactile social contact owing to research restrictions of the protocol of the primary investigation to which they were

assigned. This presents a situation in which there is a lack of opportunity for allogrooming, a normal behavior in most nonhuman primate species (Ventura, Majolo, Schino, & Hardie, 2005). The most effective intervention for alopecia from overgrooming would seem to be a compatible social partner. Although published evidence is scant, anecdotal observations at WaNPRC suggest that this can sometimes help. Nevertheless, some alopecia is from hair pulling by others (Honess, Gimpel, Wolfensohn, & Mason, 2005; Novak & Meyer, 2009), and some individuals who overgroom themselves when singly housed subsequently pluck provided partners. Given that, overall, social contact is the most effective form of enrichment for most nonhuman primates (Lutz & Novak, 2005), it would be counterproductive to suggest social separation as a therapy for aloplucking. (However, rearranging partners might be tried.)

In the case of the primary investigations to which the paint roller subjects were assigned, PWB staff worked with the investigators to help them modify research protocols to allow grooming contact (Crockett, Bellanca, Bowers, & Bowden, 1997) for some of their subjects and study phases. The investigators also have implemented some monkey training procedures and reduced the number of sedations. The investigators' current subject pool does not include any of the monkeys in the paint roller study, so changes in their alopecia since implementation of training procedures and tactile social contact cannot be evaluated.

The evaluation of paint roller effectiveness involved scoring alopecia. The process of developing an effective and representative scoring system proved difficult. Nevertheless, consistency of week-to-week scoring was overall quite high. All the alopecia scoring was done by one observer, and it is not known whether this method would produce high interobserver reliability with other trained observers. The need for high interobserver reliability is driving the development of a simpler nonhuman primate alopecia scoring system than used in this study (Crockett et al., 2009).

CONCLUSION

The results of this investigation do not support the widespread administration of paint rollers as a treatment for overgrooming. At best, certain individual monkeys may derive some benefit from this type of enrichment. Future research efforts should be directed toward preventing overgrooming before it results in alopecia. This is no doubt a difficult task as a wide variety of factors seems to play a part in the development of the alopecia (Novak & Meyer, 2009). The ineffectiveness of direct interventions such as grooming surrogates in reducing alopecia from overgrooming indicates that behavioral managers should place more emphasis on increasing social contact and implementing training procedures for nonhuman primates. These are among the refinements most likely to increase the psychological well being of laboratory primates (Jennings & Prescott, 2009). Future research could investigate the effects on alopecia of training primates to cooperate to reduce the number of sedations. Animals also might be trained to present body parts for easier viewing and scoring of alopecia.

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REFERENCES

- Baker KC, Crockett CM, Bloomsmith MA, Coleman K, & Bellanca RU (2006). Behavioral and clinical management of alopecia in nonhuman primates. *American Journal of Primatology*, 68(Suppl. 1), 89.
- Bayne KAL, Mainzer H, Dexter S, Campbell G, Yamada F, & Suomi S (1991). The reduction of abnormal behaviors in individually housed rhesus monkeys (*Macaca mulatta*) with a foraging/grooming board. *American Journal of Primatology*, 23, 23–35. [PubMed: 31952413]
- Beisner BA, & Isbell LA (2009). Factors influencing hair loss among female captive rhesus macaques (*Macaca mulatta*). *Applied Animal Behaviour Science*, 119, 91–100.
- Bellanca RU, & Crockett CM (2002). Factors predicting increased incidence of abnormal behavior in male pigtailed macaques. *American Journal of Primatology*, 58, 57–69. [PubMed: 12386914]
- Crockett CM, Baker KC, Lutz CK, Coleman K, Fahey MA, Bloomsmith MA,... Weed JL (2009). Developing a reliable laboratory primate alopecia scoring system for interfacility collaboration and on-line training. *American Journal of Primatology*, 71(Suppl. 1), 73.
- Crockett CM, Bellanca RU, Bowers CL, & Bowden DM (1997). Grooming-contact bars provide social contact for individually caged laboratory macaques. *Contemporary Topics in Laboratory Animal Science*, 36(6), 53–60. [PubMed: 16450978]
- Crockett CM, Bellanca RU, Heffernan KS, Ronan DA, & Bonn WF (2001). Puzzle ball foraging device for laboratory monkeys. *Laboratory Primate Newsletter*, 40(1), 4–7.
- Crockett CM, Bentson KL, & Bellanca RU (2007). Alopecia and overgrooming in laboratory monkeys vary by species but not sex, suggesting a different etiology than self-biting. *American Journal of Primatology*, 69(Suppl. 1), 87–88.
- Garner JP (2005). Stereotypies and other abnormal repetitive behaviors: Potential impact on validity, reliability, and replicability of scientific outcomes. *ILAR Journal*, 46(2), 106–117. [PubMed: 15775020]
- Garner JP, Weisker SM, Dufour B, & Mench JA (2004). Barbering (fur and whisker trimming) by laboratory mice as a model of human trichotillomania and obsessive-compulsive spectrum disorders. *Comparative Medicine*, 54(2), 216–224. [PubMed: 15134369]
- Honess PE, Gimpel JL, Wolfensohn SE, & Mason GJ (2005). Alopecia scoring: The quantitative assessment of hair loss in captive macaques. *Alternatives to Laboratory Animals (ATLA)*, 33, 193–206. [PubMed: 16180975]
- Jennings M, & Prescott MJ (2009). Refinements in husbandry, care and common procedures for non-human primates: Ninth report of the BVAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement. *Laboratory Animals*, 43(Suppl. 1), S1:1–S1:47.
- Lutz CK, & Novak MA (2005). Environmental enrichment for nonhuman primates: Theory and application. *ILAR Journal*, 46(2), 178–191. [PubMed: 15775027]
- Novak MA, & Meyer JS (2009). Alopecia: Possible causes and treatments, particularly in captive nonhuman primates. *Comparative Medicine*, 59(1), 18–26. [PubMed: 19295051]
- Tully LA, Jenne M, & Coleman K (2002). Paint roller and grooming boards as treatment for overgrooming rhesus macaques. *Contemporary Topics*, 41(4), 75.
- U. S. Department of Agriculture. (1991). Animal Welfare, Standards, Final Rule (Part 3, Subpart D: Specifications for the humane handling, care, treatment, and transportation of nonhuman primates). *Federal Register*, 56(32), 6495–6505.
- Velleman PF (1997). *Data desk: The new power of statistical vision*. Ithaca, NY: Data Description.

Ventura R, Majolo B, Schino G, & Hardie S (2005). Differential effects of ambient temperature and humidity on allogrooming, self-grooming, and scratching in wild Japanese macaques. *American Journal of Physical Anthropology*, 126, 453–457. [PubMed: 15386284]

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FIGURE 1.

Body map used to score alopecia. Each section was assigned a weight corresponding to the relative size of its surface area (see text for details).

FIGURE 2.

Top: New paint roller (use score = 1); bottom: used paint roller (use score = 4).

FIGURE 3. Scatter plot of experimental group coat condition improvement versus average Paint Roller Use score.