Pair-housing rather than single-housing for laboratory rhesus macaques

Viktor Reinhardt
Animal Welfare Institute,
Washington, DC 20007

Viktor Reinhardt, 4605 Crescent Road, Madison, WI 53711.

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A total of 378 adult and juvenile rhesus macaques of both sexes were transferred from single- to isosexual pair- housing arrangements. The incidence of serious injury resulting from partner incompatibility was 0.8% during the first year after pair formation. It was concluded that pair-housing offers a safe option to address the animals' social needs in compliance with federal rules and professional standards.

Key words: Macaca mulatta - husbandry - behavioral health- animal welfare- ethics

INTRODUCTION

There is a consensus that social primates, such as rhesus macaques, benefit from social housing [4,6,16,32,40]. Scientific and professional standards therefore require that, unless absolutely essential, primates should not be housed alone in a cage on a long-term basis [1, 11, 12,41,42].

Rhesus macaques have the reputation of being particularly aggressive [10,36,37] and hence unsuitable for being transferred from individual to social-housing conditions [15]. Although there is well documented evidence that group-housing of rhesus macaques is indeed associated with considerable risks of trauma and morbidity [3,9,13,14,18,31], there are no published data indicating that pair-housing them is unduly risky. Preliminary findings suggest that there are reasonably safe ways to transfer single-caged animals to pair-housing arrangements. A 90% (26/29) success rate was reported when 29 adults of both sexes were paired with surplus infants of breeding troops; none of the youngsters was seriously injured by the adult companions [17]. A 100% (5/5) success rate was reported when ten adult males were paired with each other after it was verified that future partners had established clear dominance-subordination relations during a non-contact familiarization period; there was not a single incidence of fighting during pair formation [20]. Both pairing options were tested in 15 aged, 22-33 years old subjects with equal success [25]. No noteworthy problems associated with aggression were encountered when 64 juveniles were transferred from single- to heterosexual pair-housing conditions [34].

The present study tests the systematic implementation of all three pair formation options in a primate research institution in order to comply with current federal rules stipulating that social nonhuman primates have to be housed in ways that address their "social needs" [38].

MATERIALS AND METHODS

Subjects were 456 physically healthy rhesus macaques (Macaca mulatta): 272 adults (4-34 years old), 106 juveniles (2-3 years old), 78 infants (12-18 months old). All animals had been mother raised. Adults had lived in single cages for several years prior to pair formation. Juveniles had been pair-housed with an adult animal for at least six months prior to being paired with another juvenile partner. Infants were naturally weaned. They were housed with their mothers in cages or breeding troops prior to being paired with an unfamiliar adult partner. Paired companions were not kin-related and had never lived together.

The animals were kept at the Wisconsin Regional Primate Research Center. Room temperature was maintained at 20-22°C with a relative air humidity of approximately 50% and a 12-hour artificial light/dark cycle. Commercial dry food was fed once a day between 0700 and 0900, supplemented with fruit or bread between 1400 and 1600. The animals were offered treats, such as raisins and whole peanuts, during two daily health checks.

New pairs were observed during the first 30 minutes after pair formation, checked at least three more times during the first day, and at least twice a day thereafter to evaluate their compatibility. Partners were considered to be compatible as long as none of them inflicted a serious wound (requiring veterinary care) on the other, none of them showed signs of depression (reduced alertness and interest in otherwise favored food treats), both of them obtained an adequate share of the food ration (verified during direct observations and/or regular body weight recordings), and none of them disturbed the other unduly.

Incompatible animals were not forced to live with each other but were separated and re-paired with different partners. Compatible animals, however, were allowed to stay together for at least one year.

ADULT/ADULT PAIR FORMATION

Potential companions were "randomly" selected and placed pairwise in two adjacent cages. Partners were separated from each other by a grated cage dividing panel permitting visual, olfactory, and auditory communication (Fig. 1). They were familiarized in this way for 24 hours and repeatedly observed (cumulative observation time 5-90 minutes) for signs of an established dominance- subordination relationship. The following gestures and behaviors were taken as rank-indicative when occurring in strictly unidirectional manners: "Feargrinning" [17] when being looked at by the neighbor, withdrawing and/or looking away when approached or looked at by the neighbor, and "enlisting" [5] against the observer. A rank relationship was considered to be equivocal if neither of the two subjects showed any of these subordination-indicative behaviors and/or if both subjects threatened each other across the dividing panel. No attempt was made to introduce these individuals to each other as pairs.

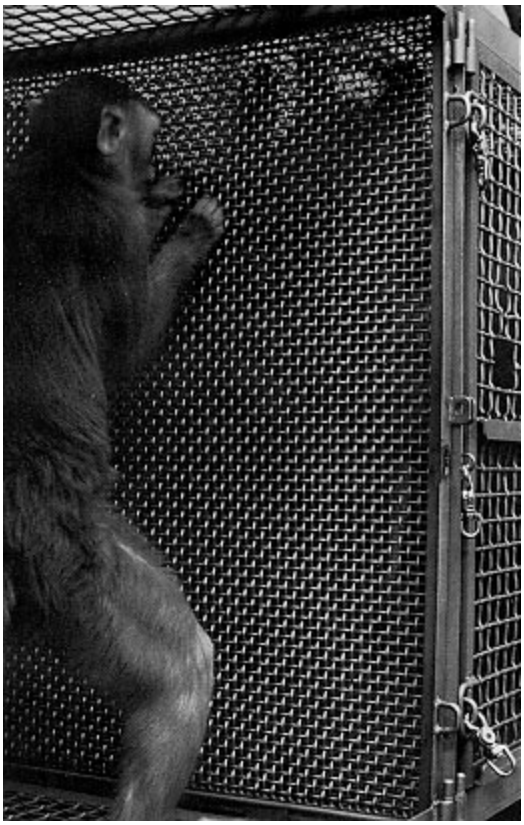

Figure 1. Separated by a grated cage dividing panel, potential partners not only get familiarized but establish dominance-subordination relationships without risk of injuring each other.

Partners with established rank relationship were transferred into a different double cage without a partition, in an environment where everything was strange to them except the other companion. Pairs were housed according to the subjects' body weights in 1.05 sq m X 77 cm (1.3 sq ft X 30.3 in) or 1.70 sq m X 85 cm (15.5 sq ft X 33.5 in) stainless steel double cages, each equipped with two food boxes or two food puzzles [28,30], two drinking spouts, two perches [24], and two gnawing sticks [24]. Double cages were created by simply removing partitions between twin modules. These partitions were changed into privacy panels [26] and re-installed after the first day of pair formation. Males had their canines blunted. All male pairs were kept in male-only areas.

The animals were assigned to various research and breeding protocols. If this involved a temporary separation of a pair for more than one week, partners were not simply re-united in their homecage, but they were given the opportunity to recognize each other across a transparent cage divider which was removed after a few seconds.

Re-pairing adults with different adult partners

Animals that lost their partners for medical or experimental reasons were re-paired with other adult conspecifics as soon as possible. Males were repaired with other males following the above outlined procedure. Females were re-paired with other females without preceding familiarization. Like original pairs, partners of new pairs were introduced to each other in an environment that was unknown to both of them.

ADULT/INFANT AND JUVENILE/JUVENILE PAIR FORMATION

Surplus infants were directly transferred into the cage of their potential adult companions without any preliminary familiarization. The same was true for juveniles, who were also paired, by one animal being directly transferred into the cage of a potential companion. Most pairs required double cages, which were created by interconnecting adjacent cages with short stainless steel tunnels [2] or by removing dividing panels between twin modules.

Figure 2. Infants trigger affectionate rather than aggressive responses in healthy adults. Here an 11-year old male protectively holding his 14-month-old cage companion.

RESULTS

Adult/adult pairs

A total of 154 females and 40 males were transferred to isosexual pair-housing arrangements. In order to form 77 female and 20 male pairs, 101 female and 24 male dyads had to be tested. Partners of 24 (23.8%) female dyads and partners of four (16.7%) male dyads failed to establish noticeable dominance- subordination relationships during the 24-hour familiarization period and were therefore not paired. Partners of the remaining dyads established clear relationships during that time and were subsequently paired.

Pair formation was accompanied by fighting within the first 30 minutes in 2. 1 % of the 97 pairs tested (two female pair, no male pair). Partners were incompatible in 13 (13.4%) cases. Incompatibility became evident during the first month in seven cases, during the remaining 11 months in six cases. It was due to aggression in six cases (6.2%), due to inadequate food sharing in five cases (5. 1 %), and due to depression in two cases (2. 1 %). Incompatibility was associated with a serious injury for 1.3% (2/154) of the paired females, and 2.5% (1/ 40) of the paired males.

Partners were compatible throughout the one year follow-up period: in 88.3% (68/77) of the female pairs and in 80.0% (16/20) of the male pairs. Partner compatibility was verified up to seven years in female pairs and up to five years in male pairs.

There were 11 females and 9 males of the test population who were continuously housed in isosexual pair conditions for five years. They lived with two to five different cagemates during that time involving the establishment of 43 new female pairs and 23 new male pairs. Re-pairing females was successful, i.e., new partners were compatible during at least one month, in 90.7% (39/43) of cases, repairing males was successful in 95.7% (22/23) of cases. Seven of the 11 females raised their offspring together with their various companions. In no instance did the presence of the young affect the adults' compatibility, but pairs had to be split in two cases when dominant females persistently "stole" the infants of their subordinate nursing companions.

Adult/infant pairs

A total of 65 adult females and 13 adult previously single-caged males were directly paired with infants of the same sex.

Partners were compatible throughout the one year follow-up period: in 93.8% (61/65) of the female/infant pairs and in 92.3% (12/13) of the male/ infant pairs. Partner compatibility was ascertained up to eight years in female/infant pairs and up to four years in male/infant pairs.

Incompatibility was noted within the first week after pair formation in three cases. It was caused by the adult animal aggressing the infant companion in two cases (one female, one male). It was due to the adult preventing the infant from getting its adequate share of the food in one case (one female). Incompatibility was noted after more than one year in the remaining two cases when young subjects started "teasing" [39] their aged companions (32 and 34 years old), thereby creating excessive disturbance for them.

Juvenile/juvenile pairs

A total of 84 female and 22 male juveniles were transferred to same-sexed pair arrangements.

All 42 female and all 11 male pairs were compatible throughout the one-year follow-up period. Male companions were occasionally observed playfully wrestling with each other, but this never resulted in serious aggression.

CENSUS

The three pair-formation options were fully integrated into the animal husbandry protocol of the Wisconsin Regional Primate Research Center when this study was terminated in March 1994. At this time, the colony comprised 728 caged rhesus macaques, of which 91.8% lived in compatible pairs (N = 644) or groups (N = 24), 8.2% (60) lived alone (their exemption from social housing was approved by the Institutional Animal Care and Use Committee).

DISCUSSION

The present findings give evidence that there are at least three recommendable options to provide social- housing for previously single-caged rhesus macaques in compliance with current federal rules.

The study involved 456 rhesus macaques subjected to either of these social-housing options for at least one year. The total incidence of serious injury resulting from partner incompatibility during that time period was less than 1% (3/456). Of the originally tested pairs, 92.1% (210/228) were compatible for at least one year. The incidence of incompatibility was 7.9% (18/228) when animals were paired for the first time, 7.6% (5/66) when they were re-paired after having lost their first partner. These data indicate that the assumption that rhesus macaques are too aggressive for social-housing does not hold true for pair-housing arrangements.

The success of the three pairing strategies is not surprising when considering that basic ethological principles were being applied:

1. Selecting potential adult companions only if they established clear-cut dominance- subordination relationships during the non-contact familiarization period made aggressive disputes over dominance rather unnecessary, and partners engaged in fighting during original pair formation only in 2. 1% of cases. This inference is supported by two other studies in which partners were also familiarized but were subsequently paired regardless of whether the animals had established rank relationships during the familiarization time. Under this condition, the occurrence of fighting during partner introduction was 40% in adult female rhesus macaques [19], and 13% and 67% in adult female and adult male long-tailed macaques (M. fascicularis) [7].
2. Pairing adult animals away from their familiar environment avoided aggressive conflicts resulting from possible territorial antagonism [19] and from indirect aggressive provocation through coalition formation with familiar cage neighbors.
3. The provision of privacy panels provided adults the option of visual seclusion, thereby reducing aggressive tension while fostering affiliative interactions [26].
4. Keeping male pairs in male-only areas avoided antagonism resulting from possible sexual competition.
5. Infants were not yet big enough to count as potential dominance rivals but triggered parental care rather than aggressive behavior in adults (Fig. 2).
6. Not being "backed-up" by adults and not yet being pressured by serious dominance ambitions, juveniles had little reason for strife.

Data have been published showing that pair formation and subsequent compatible pair-housing of rhesus macaques:

1. promotes the animals' behavioral health by providing them a species -adequate outlet for the expression of their social disposition [8,23,34] (Fig. 3).
2. has a therapeutic effect on gross behavioral disorders [8,17,23],
3. decreases rather than increases the animals' morbidity [8,35],
4. does not lead to endocrine and immune stress responses [8,27] or to undernourishment in subordinate or dominant members of compatible pairs [8,29],
5. does not interfere with routine husbandry procedures and common experimental protocols [21,22,241].

The information available indicates that there is little scientific justification for not providing healthy caged rhesus macaques a species -adequate social environment in form of pair-housing arrangements.

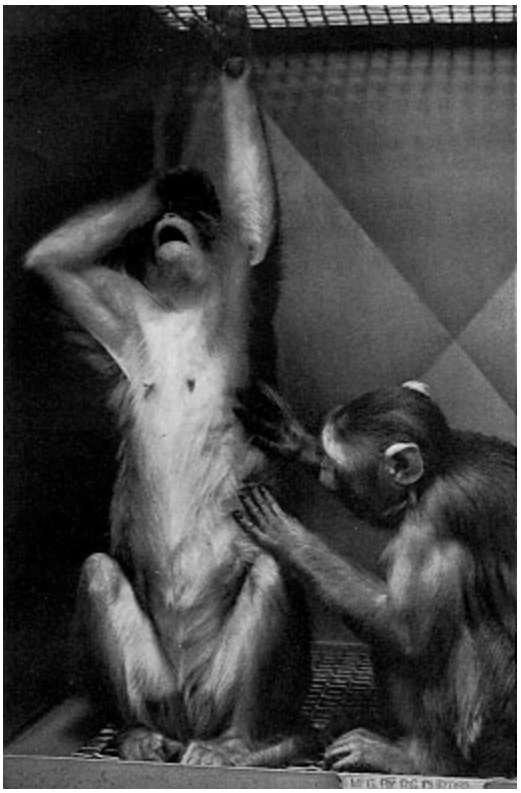

Figure 3. Pair-housing provides social laboratory primates a means to express their social disposition. Paired companions spend approximately one fourth of the time interacting with each other in species- typical ways [8,23,34]. Here two female rhesus macaques engaged in social grooming.

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