Environmental enhancement plan for previously single-caged adult rhesus macaques (Macaca mulatta)

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To promote the well-being of previously single-caged adult (older than 5 years) rhesus macaques (Macaca mulatta) and the quality of research done with them, the following environmental enhancement plan has been developed and implemented at the Wisconsin Regional Primate Research Center.

ANIMATE ENVIRONMENTAL ENRICHMENT

Previously single-caged animals are paired with compatible conspecifics in order to enable them to express their social disposition. Partner compatibility is defined as:

1. No animal inflicts a serious injury (requiring medical care) on a companion.
2. No animal shows signs of depression (reduced alertness; no interest in otherwise favoured food such as raisins, peanuts, fruit for more than 12 hours).
3. No animal shows signs of social discomfort (avoiding companion whenever being looked at).
4. Both partners secure an adequate share of the food (animals are weighed every other month).

Compatibility is checked by the attending animal care personnel at least twice each day. Incompatible animals are separated and attempts made to pair them with other partners.

Several options are available to pair previously single-caged rhesus macaques with compatible conspecifics:

1. Naturally weaned infants are removed from breeding troops at 10-18 months of age. They are directly paired with previously single-caged adults without prior familiarization. Adult-infant pairs are compatible in more than 80% of cases[1]. Compatibility depends neither on the sex, age, or origin of the adult nor on the sex of) the infant[1]. Partner compatibility has been ascertained in several cases through follow-up periods of more than 4 years.
2. Previously single-caged adults are familiarized with each other in isosexual dyads in cages in which the two animals are separated by a grated partition allowing non-contact communication only (no risk of aggression-associated trauma).

Potential companions are paired in a different cage (to avoid territorial antagonism) without partition if they show evidence of a clearly established dominance-subordination relationship (unidirectional fear-grinning and/or avoiding). If they fail to do this within one week of familiarization, they are separated and re-tested with another animal[2]. The establishment of rank relationships during non-contact familiarization is instrumental for ensuring an extremely low incidence of aggression

at pairing. Partners usually respect their already-established dominance-subordination relationship and therefore have little reason to engage in fighting[3]. Paired partners of female pairs as well as of male pairs are compatible in more than 80% of cases[3-5]. Compatibility has been ascertained throughout follow-up periods of up to 4 years. Male-male pairs are housed so that they have no visual contact with sexually receptive females (avoidance of antagonism resulting from possible sexual competition). Animals that have lost their partner and have again been caged singly are paired with each other without prior familiarization. Evidence suggests that previous exposure to another companion provides the animals with social skills necessary to adequately cope with the potential risk involved in being paired with an unfamiliar conspecific of the same sex[6,7].

Pair-housing has no negative impact on the animals' body weight[8] , stress status[9], and health[10]; it does not interfere with common research protocols[4,11].

In common with wild rhesus macaques living in troops[12,13], paired companions spend about 20% of their time interacting with each other in species-typical ways[14,15]. This indicates that pair-housing of previously single-caged compatible conspecifics promotes the well-being of the animals by providing them species-appropriate conditions for the expression of their social disposition.

Group formation of previously single-caged individuals is not implemented as a means of animate environmental enrichment because of the inherent risk of violence, injury, and death[16-19].

Animals may be housed singly but must have visual and auditory contact with other conspecifics under the following conditions:

1. intensive care;
2. pre- and postoperative care;
3. contagious diseases;
4. social incompatibility (incompatible in the course of at least three pair formation attempts);
5. specific research protocols (e.g., metabolic studies, activity studies) explicitly approved by the Institutional Animal Care and Use Committee.

INANIMATE ENVIRONMENTAL ENRICHMENT

Every rhesus macaque is provided with a perch and a gnawing-stick.

A PVC (polyvinyl chloride) pipe or a deciduous tree branch serves as a perch. The animals show no preference for either of the two types of perches[20]. Deciduous tree branches have the advantage over PVC pipes in that they are not only good for perching, balancing, and holding on to but also serve as objects for gnawing. This advantage is counterbalanced by the fact that, unlike PVC pipes, deciduous tree branches are not readily available throughout the year and have to be replaced regularly due to wear[20]. Perches are round and have a diameter of 4-8 cm to facilitate comfortable sitting[21].

In standard cages, perches are suspended diagonally with a slope of about 15°. The lower end of a perch is attached with a chain at the front of the cage, while the upper end rests at the junction of the back and side wall[22]. A perch is installed at such a height that an animal not only can sit on it but also can freely move under it. This increases the usable cage space by providing access to the vertical dimension[21]. In squeeze-back cages, perches are also installed at a height which leaves

enough leeway for the animals to move under and to comfortably sit on them. The proximate end of the perch fits into a socket mounted on the inside of the front of the cage. The far end of the perch glides in a stainless steel sleeve mounted over a hole in the squeeze-back[23].

A PVC pipe or a branch provides an animal with the means to express non-injurious species-typical activities, such as perching and balancing, that were previously inhibited due to lack of an appropriate object. Individuals spend about 15% of their time interacting with a perch, young animals more and old animal less[14,24]. Monkeys living in lower-row cages spend significantly more time perching than those living in upper-row cages[24]. There are no indications that perches lose their attractiveness over time[24]. They are particularly useful for the animals during daily cleaning of their cages as it affords them a dry, comfortable place to sit while the floors of their cages are sprayed with water[21,25]. Sitting in an elevated position (usually close to the front of the cage[21]) may increase a monkey's feeling of security by providing better visual control of the environment outside the cage[21].

Short (15-30 cm) segments of deciduous tree branches serve as gnawing-sticks[26]. They provide a means of expressing noninjurious species-typical activities such as gnawing and manipulating. The animals spend about 4% of their time interacting with gnawing-sticks, again young animals more and old animals less[14,24]. There are no indications that the monkeys lose interest in them over time[24]. Like branches, gnawing-sticks must be replaced regularly due to wear.

Foraging behaviour is promoted by offering all animals unprocessed fruit, peanuts, or vegetables daily as a supplement to the basic commercial dry food.

HUMAN-ANIMAL INTERACTIONS

The attending care personnel feed the animals favoured food items (e.g. whole peanuts, raisins, fruit loops) by hand consistent with safety precautions. These daily positive human-animal interactions are not so much intended as a means of environmental enrichment but rather to foster a human-animal relationship that is conducive to reduce undue fear reactions (e.g., biting attempts, increased adrenergic activity) of the animals when they have to be handled during routine (e.g., tb testing, medical treatment) and experimental procedures (e.g., venipuncture).

Animals assigned to experiments requiring temporary chair restraint are well familiarized with the attending experimenter (animal shows no signs of fear, e.g., defensive threatening, when being approached by the experimenter). A chair-restrained monkey is never left alone, but continual visual and auditory contact with its compatible companion is provided for psychological support[4,11].

Handling procedures are carried out in ways that minimize stress reactions in the animals and maximise the safety of the personnel. For this reason, all animals are trained to voluntarily enter transport boxes, and animals assigned to research protocols requiring regular blood sampling are trained to cooperate during in-homecage venipuncture[27-30].

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