Effective Environmental Enrichment for Caged Rhesus Macaques

Viktor Reinhardt
Wisconsin Regional Primate Research Center
1223 Capitol Court, Madison W1 53715

Environmental enrichment is designed to promote the behavioral health of understimulated nonhuman primates by providing them with species-appropriate conditions for the expression of species-typical behavioral dispositions (cf. USDA, 1991; CCAC, 1993). Housing nonhuman primates in permanent social isolation in barren cages raises self-evident ethical concerns.

In the course of eight years, I have provided effective, species-appropriate animate and inanimate enrichment for more than 700 research rhesus macaques (Macaca mulatta)previously housed in barren single cages at the Wisconsin Regional Primate Research Center (WRPRC). The environmental enhancement plan (Reinhardt, 1992a) was developed in such a way that its implementation had to be effective (long-term stimulation of individual subjects beyond the novelty effect period), safe (no special health risks) and inexpensive (both in terms of labor and financial cost). The plan addresses the following behavioral dispositions:

• Rhesus macaques are social animals who prefer compatible companionship over privacy even if this reduces their spacial freedom (Reinhardt & Reinhardt, 199 1).

• Rhesus macaques prefer the vertical over the horizontal dimension as primary living space (Bernstein & Mason, 1963; Reinhardt, 1992b; cf. for M. fascicularis: Rosenblum et al., 1994a) and will try to escape to an elevated place when frightened (own unpublished observation; cf. for M. fascicularis: Crockett & Wilson, 1980).

• Rhesus macaques voluntarily work for their food, with the expression of foraging activities serving as its own motivational reward (Reinhardt, 1994; cf. for M. arctoides:Anderson & Chamove, 1984).

• I create conditions for the expression of these species-typical characteristics in the following ways:

1. Singly caged adult rhesus macaques are transferred to a social housing condition by:

a) pairing them directly with 12-18 month old, naturally weaned surplus infants from breeding troops (Reinhardt et al., 1987a; figure 1);

Figure 1: Adult male protectively holding his infant companion shortly after pair formation

b) pairing them with each other after a short period of noncontact familiarization (Reinhardt et al., 1987b; figures 2 & 3). The establishment of dominance-subordination relationships during familiarization is instrumental in avoiding serious aggression between adult counterparts at the critical moment of pair formation (Reinhardt, 1989a).

Paired partners are compatible in more than 80% of cases (throughout follow-up periods of up to 79 months) independent of their respective age and sex (Reinhardt et al.,1987a, 1989a; figure 2; cf. sex dependency in M. fascicularis: Crockett, 1994). They are incompatible due to depression or inadequate food sharing in approximately 13%, and due to aggression in less than 1% of cases (Reinhardt, 1992c).

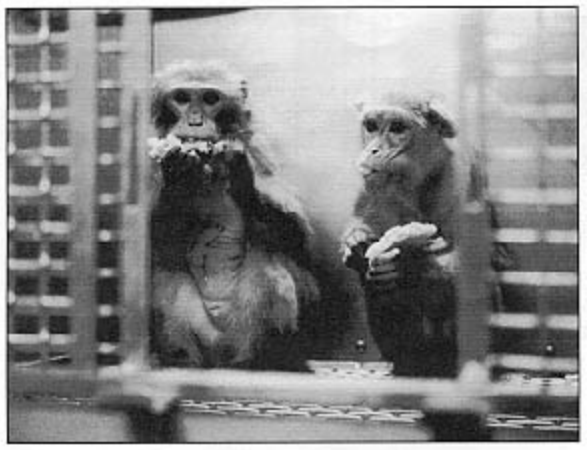

Figure 2: Food sharing is a reliable sign of pair compatibility

Paired animals share a double cage (dividing panel between two cages removed or two cages interconnected with a short tunnel) equipped with a privacy panel (Reinhardt & Reinhardt 1991; cf. Bielitzki et al., 1990) for optional visual seclusion. Male-male pairs are kept in male-only areas to avoid possible antagonism associated with sexual competition. Incompatible animals are not forced to live together but are re-paired, with other partners (Reinhardt, 1989c).

Companions who have lived with each other for more than one year express their need for social companionship by interacting with each other in species typical ways more than 20% of the 12-hour day (Ranheim & Reinhardt, 1989; Reinhardt, 1990a; Reinhardt & Hurwitz, 1993; figure 3; cf. for M. fascicularis: Line et al., 1990).

Figure 3: Grooming is the predominant social interaction between paired adults 36-year old Senila and 27-year old Sissa groom each other during 47% of a 3-hour observation (Reinhardt & Hurwitz, 1993).

Pair housing has no effect on clinical morbidity (Reinhardt, 1990b; Eaton et al., 1991), body weight (Reinhardt et al., 1988a; Reinhardt & Hurwitz, 1993), cortisol concentration (Reinhardt et al., 1991; Schapiro et al., 199 1; cf. for M. fascicularis: Crockett et al., 1991) and reproductive performance (Eaton et al., 1991), but abolishes self-injurious behavioral disorders attendant upon continual single-housing (Reinhardt et al., 1988b; cf. for M. fascicularis: Line et al., 1990). It does not interfere with common research procedure such as homecage venipuncture (Vertein & Reinhardt, 1989), headcap implantation (Reinhardt et al., 1989a), and tethering (Reinhardt et al., 1989b; cf. for Papio cynocephalus anubis: Coelho & Carrey, 1990).

2. The vertical dimension of the cage is made accessible by a PVC pipe. The perch is attached to the front of the cage (to offer the subject a vantage point for better visual control over the environment outside of the cage) and is mounted at a height that an adult animal not only can sit on it but also freely move under it (Reinhardt & Smith, 1988; figure 4).

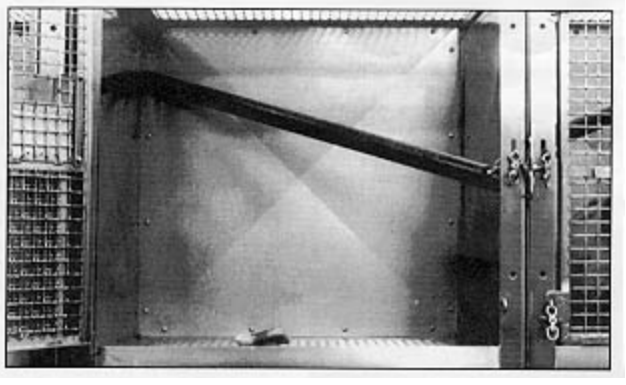

Figure 4: The vertical dimension of the cage is made accessible with low-cost addition of a PVC pipe.

Pair-housed animals spend approximately 10% (adults 6%, juveniles 14%), and single-housed individuals 25% of the 12-hour day perching on their PVC pipes after being exposed to them for one year (Reinhardt, 1989c, 1990a; Kopecky &Reinhardt, 199 1; Woodbeck & Reinhardt, 1991; cf. Shimoji et al., 1993).

3. Foraging behavior is promoted by a) offering each caged subject a gnawing stick, and b) a food puzzle. Gnawing sticks consist of loose segments of red oak branches (Champoux et al., 1987; Reinhardt, 1992d). The animals use them for gnawing and manipulating without adverse effects approximately 4% (adults 2%; juveniles 7%) of the 12-hour day after being exposed to them for one year (Reinhardt 1990a; cf. Line & Morgan, 199 1; figure 5). The sticks have to be replaced every 3-6 months due to gradual wear.

Figure 5: A red oak branch segment costs nothing but provides species- appropriate stimulation and a means of dental care.

Food puzzles are ordinary food boxes remounted a few centimeters away from their original positions so that they no longer cover the access holes. An animal has to maneuver food items with the fingers into appropriate positions behind the mesh to retrieve them with teeth and/or finger (figure 6). Animals habituated to using the puzzle as primary feeder for one month, devote approximately 7% of the 12- hour day to foraging for their daily standard biscuit ration (Reinhardt, 1993a). Working for food has no adverse impact on an animal's general health as reflected in body weight (Reinhardt, 1993b). Custom-made food puzzles are particularly cost and work-effective enrichment devices because they require no extra material (the ordinary food boxes are used), no extra maintenance (same cleaning as food boxes), and no special baiting (food puzzles are used as primary feeders for the standard monkey biscuits).

Figure 6: Retrieving the standard biscuit ration from a food puzzle instead of a food box increases foraging time more than 100 fold (Reinhardt, 1993a)

The environmental enhancement plan of the WRPRC can serve as an example that effective and safe enrichment can readily be provided for caged rhesus macaques without undue cost. The program promotes the behavioral health of the animals by offering them attractive species-appropriate stimuli for the expression of a variety of species-typical activities that were formerly inhibited due to understimulation.

The enriched environment distracts the animals more than 1/3 of the day: They spent approximately 20% of the time interacting with the companion, 10% perching on the PVC pipe, 4% gnawing/manipulating the branch segment and 7% foraging for primary food. The environmental enhancement plan for the caged rhesus macaque colony has been implemented with equal success for the 40 caged stumptail macaques (M. arctoides) of the WRPRC (Reinhardt, 1990c,1994b, 1994c).

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