

EMORY UNIVERSITY POLICY ON ENVIRONMENTAL ENRICHMENT FOR NONHUMAN PRIMATES

INTRODUCTION

The Animal Welfare Act requires that institutions maintaining primates have a management plan for the provision of an environment that is "adequate to promote their psychological well-being." Accordingly, the Yerkes Primate Research Center has developed an institutional program, The Yerkes/Emory Primate Enrichment Management Plan, to monitor, evaluate and further develop such activities at the Center. This program employs procedures compatible with the management of large numbers of animals and the diverse research and training goals of the Center. Enrichment techniques are chosen on the basis of (and future elaboration will be guided by) published findings, research results, qualitative assessments, potential promise, professional judgment, research requirements, and feasibility for a large colony with varied housing and facility design.

The Yerkes/Emory Primate Enrichment Management Plan is designed to take into account human and animal welfare concerns, while not interfering with the research programs of Yerkes/Emory Scientists. Components include: social enrichment, feeding enrichment, enrichment objects (structural enhancements, manipulable objects, devices), and sensory and occupational enrichment. No component is employed as the sole form of enrichment: several categories of enrichment are used for each individual, with emphasis varying according to any required restrictions on other forms. The plan is based on current practices and will change in accordance with research findings concerning effective enhancements to primate environments.

ENVIRONMENTAL ENRICHMENT OPTIONS

There are several factors that potentially promote the well-being of caged primates. Those currently being most commonly used or studied can be divided into social and non-social enrichment.

Social Enrichment

Group or Pair Housing Social housing is the primary strategy for the nonhuman primates at Yerkes/Emory and will continue to be promoted as an appropriate means of providing enrichment when it is compatible with ongoing and anticipated research protocols, animals' health and general well-being. While species-typical groupings (e.g. compound housing) clearly provide the richest and most naturalistic social stimulation, this housing setting is often not possible for animals used in biomedical research. The possibility of traumatic wounds (i.e. Baker et al. 2000) and a greater incidence of disease transmission must be taken into account when considering socially housed animals, and a level of acceptable risk should be established by the attending veterinarian (Novak and Drewsen 1988), as levels of trauma and incompatibility can be significant in some circumstances (Reinhardt et al. 1987a; Conlee et al. 1996). Another potential drawback of social housing of nonhuman primates is the induction of separation anxiety, resulting

from subsequent physical separation of animals that have bonded together (mother/infant or peer/peer) (Suomi et al. 1970, 1976).

Recent research indicates that social housing can be an extremely effective and powerful enrichment strategy for captive primates, as measured through behavioral, physiological, immunological, and clinical indicators (Brent et al. 1989b; Reinhardt et al. 1987a, c, 1988, 1995; Reinhardt 1989, 1994a, b; Line et al. 1990; Bayne et al. 1991a, 1992b; Crockett et al. 1994; Eaton et al. 1994; Baker 1996; Bellanca et al. 1996; Shapiro and Bushong 1994; Shapiro et al. 1996a, b). However, the variables that influence the outcome of introductions are poorly understood (for a review, see Reinhardt and Reinhardt 2000). Not all primates benefit from social housing, due to species and sex differences in sociality, as well as age and rearing condition (Coe 1991; Ruppenthal et al. 1991; Crockett et al. 1994; Rosenblum and Andrews 1995). Rearing experience has long been known to have persistent consequences on later social competency, cognition, behavioral abnormalities, and neophobia (e.g. Mason 1960, 1961a, 1963; Harlow and Harlow 1969; Ruppenthal et al. 1976; Suomi and Ripp 1983; Champoux et al. 1992). The literature suggests that the success of introductions and its impact on well-being may vary for monkeys with different rearing backgrounds

Protected Contact Grouping. Protected contact is a feasible means for providing social contact to animals that otherwise could have none. While the behavioral, clinical, and physiological effects of full socialization have been studied extensively, there is little information on the effect of protected contact socialization (i.e. with grooming panels between caging). However, there is some evidence that protected contact housing confers behavioral benefits similar (Baker 1999) to what is observed under conditions of full-access social housing (Eaton et al. 1994). Crockett and colleagues have reported on the compatibility of several monkey species and the effect of sex differences in these species (Crockett et al. 1995, 1996, 1997; Crockett and Heffernan 1998). Few studies have investigated physiological or reproductive parameters (but see Bellanca et al. 1996; Wallis and King, 1986).

In a biomedical setting, social housing for monkeys typically involves small groups housed in cages, whether animals have full access into each other's cages or whether they have protected contact through grooming partitions. While full access provides for the widest range of social behavioral patterns, it lacks escape routes, visual barriers, space to run from aggressors, and the choice of whether to be in proximity and interact. Full contact appears to pose more risk of stress and injury to the animals, including the potential for food monopolization by dominant individuals. While many primates possess social mechanisms for controlling aggression under crowded conditions (e.g. Nieuwenhuijsen and de Waal 1982, Aureli et al. 1995, 1997; Judge and de Waal 1997), a caged setting and a social group size of two may pose challenges that can be lessened by the presence of a barrier. This suggestion, however, has not been objectively evaluated. The risks and benefits of both options must be measured in order to determine which best provides for well-being in a caged setting.

Single housing. When tactile contact is not feasible, non-contact social access is provided in the vast majority of cases. The importance of olfactory and visual signals in nonhuman primate communication has been documented in many species (Zeller 1987; Novak and Suomi 1989). Auditory communication is also important and occurs at high

levels between animals in a room or in adjacent enclosures (Novak and Suomi 1988). Visual contact between group-living species can often ease the stress from what would otherwise be an isolated environment, if special attention is paid to animal arrangement (Bayne 1991). For example, care must be taken so that an overly aggressive animal does not cause distress to a submissive animal in direct visual contact.

When animals are in a room with a physical configuration that prohibits direct viewing of cage neighbors, the provision of mirrors along an otherwise empty wall can be of benefit (Bayne 1991). However, the behavioral effects of wall-mounted mirrors as an enrichment strategy have been investigated only in chimpanzees (Lambeth and Bloomsmith 1992; Brent and Stone 1996), a species with the capacity for self-recognition (Gallup 1970; Calhoun and Thompson 1988; Suarez and Gallup 1981; Povinelli et al. 1993). For species apparently without such abilities (e.g., macaques: for reviews see Gallup 1987 and Anderson 1984), mirrors can cause distress (Riviello et al. 1993), and alternative mirror presentations may prove more beneficial (O'Neill-Wagner et al. 1996) (e.g., manipulable mirrors, or wall-hung mirrors mounted at an angle).

When conspecific contact is not possible, primate/human interaction can augment the social environment. Positive human interaction via the provision of nutritionally balanced food treats by the animal care staff (Bayne et al. 1993b) have been shown to reduce abnormal behavior in singly-housed monkeys. Human interaction benefits animals in other housing settings as well. Positive reinforcement training (Bloomsmith et al. 1999) or other forms of human interaction (Baker 1997), has been shown to have beneficial behavioral effects in chimpanzees. Further research is required to identify optimal interaction types and the populations that most benefit from human interaction (Fox 1986).

Non-Social Enrichment.

Feeding Enrichment. Variations in food and the ways that food is provided are important components of a comprehensive enrichment program. Natural feeding behavior can be approximated by providing varied produce in addition to the basic diet, increasing meal frequency, and providing foraging opportunities by scattering feed in substrate material (Chamove and Anderson 1979; Chamove et al. 1982, 1984; Anderson and Chamove 1984; Tripp 1985; Westergaard and Fragaszy 1985; Maple and Finlay, 1986; McKenzie et al. 1986; Bloomsmith et al. 1988; Bryant et al. 1988; Bloomsmith 1989; Boccia 1989a, b; Byrne and Suomi 1991; Nadler et al. 1992; Baker 1997). These types of activities require consideration of sanitation and potential disease transmission.

Enrichment Devices. Species-typical exploratory, manipulative, postural, locomotor, foraging, and social behavior can be promoted by increasing the amount, variety, and complexity of usable space, and by providing objects and devices.

The provision of ropes, hoses, hanging toys, perches, and visual barriers encourage such activities, with proper attention being paid to animal safety (Reinhardt et al. 1987b; Bryant et al. 1988; O'Neill 1988; Reinhardt and Smith 1988; Wolff 1989; Reinhardt 1990; Bayne et al. 1989; Eichberg et al. 1991; Kopecky and Reinhardt 1991; O'Neill et al. 1991). Destructible material (Bryant et al. 1988; Pruetz and Bloomsmith 1992) as well as durable manipulable objects such as toys (Renquist and Judge 1985; Bryant et al. 1988;

Bayne 1989; Brent et al. 1989a; Crockett et al. 1989; Bloomsmith et al. 1990a; Pruetz and Bloomsmith 1992; Bayne et al. 1993a; Brent and Stone 1996) can be enriching, particularly for individuals in restricted social conditions.

Numerous devices have been designed to promote problem-solving, foraging, and to provide outlets for manipulative and exploratory tendencies (Bloomstrand 1986; Harris 1988; Bloom and Cook 1989; Line and Houghton 1987; Line et al. 1989; Maki et al. 1989; Hayes 1990; Bayne et al. 1991b, 1992a; Brent and Eichberg 1991; Gullekson et al. 1991; Lam et al. 1991; Murchison 1991, 1992, 1994; Bayne et al. 1994; Lambeth and Bloomsmith 1994; Lutz and Novak 1995; Shapiro and Bloomsmith 1995).

Sensory and occupational enrichment. Enhancement strategies employing videotapes, radios, water pools, joy-stick tasks, etc., can increase the sensory complexity of the environment and provide locomotor or cognitive challenges. Such strategies have been relatively poorly investigated, but hold promise for effectively augmenting the captive environment (Novak and Drewsen 1988; Brent et al. 1989a; Bloomsmith et al. 1990b; Parks and Novak 1993; Anderson et al. 1994; Brent and Weaver 1995; Brent and Stone 1996; Bloomsmith et al. 1990; Lambeth and Bloomsmith in press).

PLAN

The focus of the Yerkes/Emory enrichment program is to optimize opportunities for species-typical non-injurious behavior, including social, locomotor, and foraging behavior, in our primates. Yerkes/Emory is committed to a program in compliance with the Guide for the Care and Use of Laboratory Animals and the Animal Welfare Act, as well as with behavioral research so that we can guide and modify the program toward the most effective enhancements. Yerkes/Emory has established a Primate Enrichment Unit working in conjunction with the Enrichment Committee and the Animal Care and Clinical Veterinary Resources Units, which has addressed enrichment over the long term. These units form an integrated group of personnel responsible for research, daily implementation, and regular psychological and physical assessments of Yerkes' primates.

The Yerkes/Emory enrichment plan employs seven general categories of enrichment, none of which are used to the exclusion of other categories. Most animals have access to several categories of enrichment, and when some forms of enrichment are restricted, additional emphasis is placed on other forms, e.g., increased primate/human interaction or sensory enrichment for individuals without conspecific social contact. It is incumbent upon investigators to specify in IACUC proposals types of enrichment that would interfere with the research protocols. IACUC proposals include a written **scientific** justification for any exclusions from some or all parts of the plan. Research-related exemptions are reviewed no less than annually. Clinically justified exemptions are reviewed every month by the attending veterinarian.

1. Group or pair housing. The Yerkes Center/Emory has been long aware of the positive aspects of social housing for promoting the fullest range of species-appropriate behaviors. The majority of the animals at Yerkes are housed with companion animals. Most Great Apes are pair or group housed as are approximately 70% of the monkeys in the Center's colony. Through the use of cage modifications and tunnels, a socialization program is in place in order to reduce the number of singly caged primates at the Yerkes Center, within the constraints recognized in the Animal Welfare Act and those imposed by research requirements.

Yerkes/Emory anticipates minimal nursery rearing of Great Apes. In the event that Great Ape infants require removal from their mothers due to illness on the part of the mother/infant or due to maternal neglect or abuse, they are raised with peers when possible. Nursery-reared great apes are later moved to cages with experienced adult conspecifics when possible. Toys with which the youngsters are familiar are also moved with them in an attempt to decrease the stress of moving to an unfamiliar setting.

Infant monkeys are removed from their mothers due to maternal or infant illness or due to maternal neglect or abuse, in addition to requirements for nursery-reared infants for experimental protocols. Infants moved to the nursery receive extensive human attention. Also, after removal from isolettes, infants are socialized with peers for several hours a day except where prohibited by research protocols. This socialization is conducted in large "play cages" which are outfitted with toys, climbing devices and perches. Those infants who cannot be socialized due to experimental protocols are placed alone in a play cage on a rotating basis. When infants are removed from the nursery setting, they are placed in social groups in cages with toys and perches. At a suitable age, larger groups may be formed in runs consisting of these nursery-reared peer groups, plus mother-reared

infants of comparable age and suitable adult animals, unless prohibited by research protocols.

This form of social housing is employed unless it is unsuitable due to “the health and well-being of the individual primate, unavailability of compatible individuals, the scientific requirements of a protocol approved by the Emory University Institutional Animal Care and Use Committee, or the animal's assignment to an IACUC-approved project that will result in euthanasia or disposition within 60 days.”

2. Protected contact housing. Social contact via grooming partitions is provided only when full contact is not possible, such as when research subjects are on diets or feeding schedules different from other individuals, if social dynamics would be excessively disrupted through frequent removal of individuals from primary housing, or to protect individuals from injury to surgical sites or experimental appliances. In these circumstances, some degree of social access is still permissible. Also, attempts are made to provide social access through protected contact to individual animals that cannot be housed successfully in full contact due to repeated wounding or evidence of psychological distress following introductions.

3. Single housing. Housing without social contact is employed if avoidance of all degree of social contact is necessary (and scientifically justified) for research protocols, or if individual animals cannot be housed successfully with contact. Singly caged animals have visual, auditory, and olfactory contact with at least one social partner, permitting the expression of non-contact social behavior. Areas where animals cannot directly see conspecifics have mirrors installed so that animals can see their neighbors as well as themselves, except in such cases in which individual animals show a detriment in behavior in the presence of the mirror.

4. Primate/Human Interaction. Precautions are taken to ensure personnel safety and unnecessary primate/human physical contact is discouraged. In keeping with the demonstrated benefits of positive human interaction to primates there is considerable human-animal interaction each day. Human interaction above the minimum required for husbandry, veterinary care, or research protocols is provided regularly to singly-caged primates by appropriate personnel. In addition, positive human interaction provided solely as a form of enrichment is an explicit element of the caretaking job. For example, carestaff, whose training includes knowledge of social signals, appropriate behavior toward (and conduct in the presence of) nonhuman primates, provide enrichment treats daily in a non-threatening manner. Lastly, Great Apes housed singly due to short-term research projects or long-term incompatibility with potential cagemates receive additional human interaction on a regular basis.

5. Feeding enrichment. The primary diet for all primates is a commercial primate diet, which is fed twice a day. Additionally, every animal in the colony is given at least half an orange daily (exception: one quarter orange for squirrel monkeys). Yerkes/Emory has opted to insure vitamin C requirements by providing fruit instead of pelletized supplements, since the Center feels that the fresh fruit, with its different textures, seeds, skin, etc., provides enough additional enrichment to warrant the extra expense. Primates are also given a wide array of produce with varied presentations (such as finely chopped or frozen) to further increase variety into their environment. These fruit or vegetable treats are fed as a separate meal in order to increase meal frequency and more closely

approximate natural feeding behavior. Varied treats, such as peanuts, seeds, raisins, or other treats are provided daily. In addition, squirrel monkeys and capuchins are given a daily mixture of infant formula, bread, and vitamins/folic acid. Foraging behavior is encouraged by the addition of substrates to caging or flooring where feasible.

6. Enrichment objects

a. Structural enhancements - Group housed animals and all Great Apes have various types of items to increase usable space and stimulate natural locomotion, as well as provide escape routes and visual barriers. The structures available vary according to the nature of the housing. Concrete culverts, cargo nets, firehoses, and visual screens, for example, are used in large compounds. Perches, chains, climbing equipment, swings are also used in a variety of housing conditions. Several areas are equipped in summer with shade tarps to moderate summer temperatures. All monkey cages include a perch.

b. Manipulable objects - Play objects encourage exploratory, manipulative, and display behaviors. Plastic 55-gallon drums and Boomer Balls® are also provided to group housed animals and all Great Apes. Destructible materials such as butcher paper and cardboard boxes are regularly provided to Great Apes as well. All singly housed monkeys are given at least one manipulable object such as a Kong®, Nylabone®, PVC, or other commercially available style of toy.

c. Devices - Astroturf foraging boards and fleece grooming boards are provided to a proportion of the overall singly housed monkey population on a periodic basis. Such devices are also provided should a monkey exhibit psychological distress. Expansion of the number and design varieties is ongoing, with the goal of eventually providing a device to every singly caged monkey, providing opportunities for natural foraging and grooming outlets to those individuals who could otherwise not perform these behaviors.

7. Sensory and occupational enrichment. Augmenting sensory stimulation by means of videotape viewing is currently targeted to Great Apes with restricted social enrichment and/or those lacking access to the out of doors. This strategy may be expanded in the future, along with the development of providing a method for controlling extra-cage devices. Additionally, several indoor Great Ape and monkey areas have been equipped with radios that provide varied music throughout the day. By stimulating play, exercise and problem-solving, enclosure additions such as bedding and water sprinklers (in summer) are techniques also used at Yerkes.

Special Considerations

1. Infants and Juveniles. All infants and juveniles that are non-mother reared are cared for in nurseries in which they receive social enrichment, human interaction, food, and enrichment objects appropriate to the various ages.

2. Animals Exhibiting Psychological Distress. The following criteria are used to determine psychological distress: self-mutilation, frequent stereotypies, over-reaction to stimuli, physical appearance, appetite, and an increase in disease processes, e.g., diarrhea and rectal prolapse. Each animal exhibiting such distress is assessed on an individual basis by veterinary and enrichment staff. Strategies to reduce distress often vary from animal to animal; however, the general procedure is to first augment the enrichment to the

caging environment, assess extra-caging social dynamics and make alterations where appropriate. Each animal displaying signs of distress is provided one or more enrichment devices such as foraging or grooming boards and is monitored several times a week to track progress and ensure that all required enrichment is present. Occasionally it is necessary to use both environmental and pharmacological interventions.

3. Restricted Activity Due to Research Protocols. Currently, the only animals with restricted activity are those animals involved in research protocols requiring chair restraint. Usually, these animals are restrained for short periods of time. Chair-restrained animals are closely monitored and receive special attention throughout the entire restraint period. Unless exempted by the IACUC-approved research proposal, unrestrained activity is permitted for at least one continuous hour if the period of constraint is over 12 hours.

4. Individually Housed Primates Unable to See or Hear Like Species. While it is highly improbable that an animal would ever be housed at the Center where it could not hear or see like species for any length of time, it is possible for short-term research or clinical reasons. In rare cases, individuals exhibiting psychological distress require housing without visual access to others in order to prevent self-aggression. Areas where animals would be isolated are provided mirrors when beneficial, so that the animals can see themselves. They also receive increased human attention, supplementary food treats and foraging tasks, videotape viewing, and/or additional cage enrichment objects.

5. Great Apes Weighing over 110 lb. The Yerkes Center has a large number of adult Great Apes that fall into this category. These animals, as well as animals that weigh less, are housed in appropriately sized cages, usually indoor/outdoor units. Food and enrichment devices are also scaled to meet the needs of these animals.

Documentation and Monitoring

The animal records system includes information on social enrichment status, and flags individuals exhibiting psychological distress, including any required pharmacological interventions. The animal records system generates room censuses that flag individuals with current or chronic behavioral problems. The Primate Enrichment Unit maintains records of the type of techniques employed, progress, and outcome for individuals exhibiting psychological distress, and performs quantitative assessments of enrichment technique with currently insufficient published scientific evaluation.

The primate population is evaluated frequently by enrichment and veterinary staff for signs of psychological distress, social compatibility, and presence of required enrichment techniques. Enrichment objects are also monitored regularly so that they can be removed for cleaning, repair, or replacement as needed.

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