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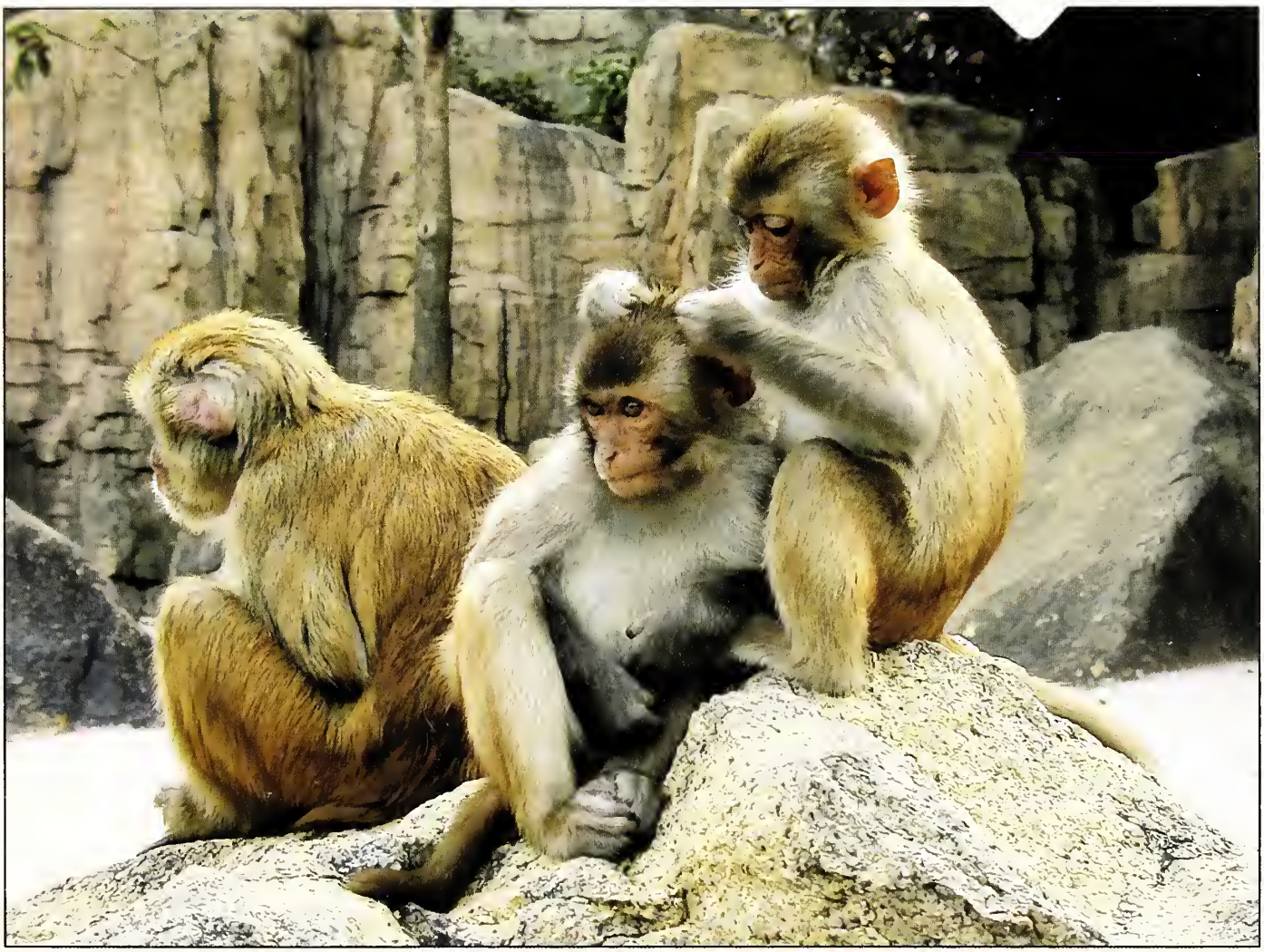
Environmental Enrichment for Nonhuman Primates Resource Guide

June 2006



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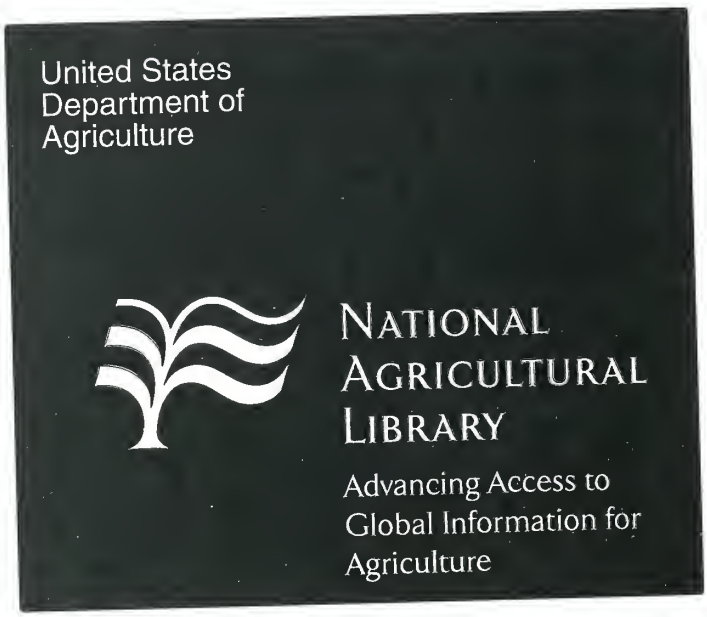
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Environmental Enrichment for Nonhuman Primates Resource Guide

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About this Document

Introduction

This publication updates and expands ***AWIC's Environmental Enrichment for Nonhuman Primates Resource Guide, January 1992-February 1999***. It covers literature published from 1999-June 2006.

USDA Draft Policy and Final Report

This document includes

- the draft policy published in the Federal Register on July 15, 1999 by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Care *and*
- the Final Report on Environment Enhancement to Promote the Psychological Well-being of Nonhuman Primates that was drafted by a committee of experts from areas of research, teaching, regulation, and exhibition and led to the draft policy.

Relevant sections of United States *Animal Welfare Act* and regulations are also included as well as parts of the ***Guide for the Care and Use of Laboratory Animals*** (NRC, 1996).

Bibliography Background

The bibliographic chapters are divided into subject areas that cover

- the concept of environmental enrichment,
- enrichment for nonhuman primates overall,
- abnormal behavior exhibited by nonhuman primates,
- great apes and gibbons,
- macaques,
- old world monkeys other than macaques,
- marmosets and tamarins,
- other new world monkeys,
- lemurs, lorises, and tarsiers,
- animal training as an enrichment strategy, *and*
- books and proceedings from conferences focused on environmental enrichment or nonhuman primate management.

Citations included in these chapters were published between 1999 and June 2006 and selected from searches conducted using a variety of agricultural, medical and life science databases. In each chapter, the citations are arranged alphabetically according to the last name of the primary author.

Citation Information

Each citation in the bibliographies contains descriptor terms, an abstract when available, and the NAL call number if the particular source is available at the National Agricultural Library (NAL).

Web Site Resources Information

The Web site resources are divided into 6 sections:

- resources on environmental enrichment, for all species and nonhuman primates,
- organizations and professional societies whose members may be involved in nonhuman primate management or research,
- United States National Primate Centers, funded by grants through the National Institutes of Health (NIH), National Center for Research Resources (NCRR), Division of Comparative Medicine (DCM),
- additional university primate centers and animal colonies located in the United States and associated territories,
- environmental enrichment products and supplier information, *and*
- discussion groups on nonhuman primates and enrichment.

Readers are cautioned as to the dynamic nature of the internet and the fact that web addresses and content are subject to change. All sites are current as of June 2006.

How to Obtain Materials from NAL

Information on how to request materials that are included in the collection of the National Agricultural Library (NAL) may be found at: http://www.nal.usda.gov/services/request.shtml.

Introduction

In 1985, the Animal Welfare Act (AWA) was amended to include, among other things, providing for the psychological well-being of nonhuman primates. In time this concept became synonymous with the terms "environmental enrichment" or "environmental enhancement." The Congressional delegates responsible for the new amendments intended to allow for more exercise, play, and compatible social interactions for captive nonhuman primates. In 1989, the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) responded to the new AWA amendments by drafting regulations based on the advice received from a group of 10 primate experts. These proposed regulations contained requirements for social housing, inanimate enrichment items, and exercise for nonhuman primates. APHIS eventually amended the regulations with more general language after receiving public comments on the proposed standards. The regulations became a final rule in 1991 and still exist today (9 CFR Sec. 3.81). (For more information on the history and intent of the 1985 amendments, see Kulpa-Eddy et al., 2005.)

After five years of enforcing the regulations on environmental enrichment for nonhuman primates, APHIS surveyed their Animal Care (AC) inspectors about the implementation of enrichment plans at research facilities, exhibitors, and dealers. The consensus among AC inspectors was that most facilities did not understand how to develop an adequate environmental enrichment plan that would promote the well-being of nonhuman primates. In response to this concern, additional clarification was set forth in the *Final Report on Environment Enhancement to Promote the Psychological Well-being of Nonhuman Primates* which was included in a draft policy and issued for public comment on July 15, 1999. Ultimately, the policy was not implemented. However, the draft policy and Final Report did provide a great deal of science-based information for facilities housing nonhuman primates and many began implementing aspects identified under five general elements (social grouping, social needs of infants, structure and substrate, foraging opportunities, and manipulanda). Both the draft policy from the Federal Register and the *Final Report on Environment Enhancement to Promote the Psychological Well-being of Nonhuman Primates* are included in this information resource.

Environmental enrichment is defined by the Library of Congress as "enhancing the environment of confined animals in order to encourage natural behaviors and improve their quality of life (Kreger, 1999)." An effective environmental enrichment program enhances species-appropriate behaviors and activities, increases behavioral choices, and encourages appropriate responses to environmental challenges. Environmental enrichment for nonhuman primates can include provision of novel objects, increased foraging opportunities, and opportunities for social interaction. After the 1985 AWA amendments, many facilities initially approached environmental enrichment as simply giving the animals toys. However, in response to published research and

input from specialists, including the writers of the USDA draft policy, many facilities housing nonhuman primates now regard their enrichment plans as part of a larger behavioral health and management program. Weed and O'Neill-Wagner (2006) discuss the evolution of behavioral management programs in zoos and laboratory research environments starting on page x*vii* of this document. The creation of a successful behavioral management program and subsequent environmental enrichment plan is based on an understanding of the natural history of each particular species. Facilities that maintain nonhuman primates in captivity develop enrichment plans by taking into account species-appropriate behavior, individual animals' medical and behavioral histories, and the current limitations of the setting. The safety of the animals and personnel should always be considered.

In the United States, USDA, APHIS, AC is responsible for enforcement of the AWA. AC implements the standards for humane care set forth in the AWA and regulations and achieves compliance through inspections of regulated facilities, educational programming, and cooperative efforts with other agencies and organizations. For laboratory animal care, the National Institutes of Health (NIH), Office of Laboratory Animal Welfare (OLAW) enforces the *Public Health Service (PHS) Policy on Humane Care and Use of Laboratory Animals* for researchers receiving federal funding from PHS. The contact information for both agencies is provided in the following section.

References

Kreger, M. (1999). *Environmental Enrichment for Nonhuman Primates Resource Guide*. USDA, Animal Welfare Information Center: Beltsville, Maryland, USA, 115 p.

Kulpa-Eddy, J.A., S. Taylor, and K. Adams (2005). **USDA Perspective on Environmental Enrichment for Animals**. *ILAR Journal* 46(2): 83-94.

Weed, J.L. and P.L. O'Neill-Wagner (2006). **Animal behavior research findings facilitate comprehensive captive animal care: The birth of behavioral management**. In: *Environmental Enrichment for Nonhuman Primates Resource Guide, AWIC Resource Series No. 32*. USDA, Animal Welfare Information Center: Beltsville, Maryland, USA, 262 p.

U.S. Government Agency Information

U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Office of Animal Care (AC)
APHIS/AC enforces the Animal Welfare Act and develops animal care regulations for exhibitors, researchers, and animal dealers. APHIS/AC answers questions regarding the regulations including those about the psychological well-being of nonhuman primates. The staff also refers patrons to regional offices where they can communicate directly with Animal Care inspectors and veterinary medical officers.

Contact Information:

4700 River Road

Unit 84

Riverdale, Maryland 20737-1234 USA

Tel: (301) 734-7833; Fax: (301) 734-4978

E-mail: ace@aphis.usda.gov

Web: http://www.aphis.usda.gov/ac/

Department of Health and Human Services (DHHS), National Institutes of Health (NIH), Office of Laboratory Animal Welfare (OLAW)
Located at the NIH, Office of Extramural Research, OLAW enforces the *PHS Policy on Humane Care and Use of Laboratory Animals* for researchers who receive Public Health Service funding. It produces conferences and workshops relating to responsible animal care and use in biomedical research. OLAW can provide guidance on the development of plans to enhance psychological well-being of nonhuman primates. The PHS Policy requires adherence to the Animal Welfare Act regulations and the *Guide for the Care and Use of Laboratory Animals*.

Contact Information:

National Institutes of Health, Office of Extramural Research

OLAW, Division of Animal Welfare

6100 Executive Blvd., Suite B01

Rockville, Maryland 20892-7507 USA

Tel: (301) 496-7163; Fax: (301) 402-2803

E-mail: olaw@od.nih.gov

Web site: http://grants.nih.gov/grants/olaw/olaw.htm

U.S. Laws, Regulations and Guidelines for Environmental Enhancement of Nonhuman Primates

In the 1985 amendments to the Animal Welfare Act (Improved Standards for Laboratory Animals Act), Congress included mention of "psychological well -being" for nonhuman primates. Included below are the text from the *Animal Welfare Act* and the final version of the regulations as they appear in the *Code of Federal Regulations*.

In addition to the Animal Welfare Act, those who receive funding from the Public Health Service or are accredited by the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC) must also comply with the *Guide for the Care and Use of Laboratory Animals*, which is based on a performance standards approach. The 1996 Guide is intended to assist institutions in caring for and using animals in ways judged to be scientifically, technically, and humanely appropriate. The *Guide* contains standards related to environmental enrichment in the section "Animal Environment, Housing and Management" and are included below.

Animal Welfare Act as amended
7 U.S.C. § 2143 - Standards and certification process for humane handling, care, treatment, and transportation of animals

(a)(1) The Secretary shall promulgate standards to govern the humane handling, care, treatment, and transportation of animals by dealers, research facilities, and exhibitors.

(2) The standards described in paragraph (1) shall include minimum requirements--

(B) for exercise of dogs, as determined by an attending veterinarian in accordance with the general standards promulgated by the Secretary, and for a physical environment adequate to promote the psychological well-being of primates.

Title 9, *Code of Federal Regulations*, Subchapter A – Animal Welfare
Part 3 Standards, Subpart D Specifications for the Humane Handling, Care, Treatment, and Transportation of Nonhuman Primates, Section 3.81

Sec. 3.81 Environment enhancement to promote psychological well-being.

Dealers, exhibitors, and research facilities must develop, document, and follow an appropriate plan for environment enhancement adequate to promote the psychological well-being of nonhuman primates. The plan must be in accordance with the currently accepted professional standards as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. This plan must be made available to APHIS upon request, and, in the

case of research facilities, to officials of any pertinent funding agency. The plan, at a minimum, must address each of the following:

(a) Social grouping. The environment enhancement plan must include specific provisions to address the social needs of nonhuman primates of species known to exist in social groups in nature. Such specific provisions must be in accordance with currently accepted professional standards, as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. The plan may provide for the following exceptions:

(1) If a nonhuman primate exhibits vicious or overly aggressive behavior, or is debilitated as a result of age or other conditions (e.g., arthritis), it should be housed separately;

(2) Nonhuman primates that have or are suspected of having a contagious disease must be isolated from healthy animals in the colony as directed by the attending veterinarian. When an entire group or room of nonhuman primates is known to have or believed to be exposed to an infectious agent, the group may be kept intact during the process of diagnosis, treatment, and control.

(3) Nonhuman primates may not be housed with other species of primates or animals unless they are compatible, do not prevent access to food, water, or shelter by individual animals. and are not known to be hazardous to the health and well-being of each other. Compatibility of nonhuman primates must be determined in accordance with generally accepted professional practices and actual observations, as directed by the attending veterinarian, to ensure that the nonhuman primates are in fact compatible. Individually housed nonhuman primates must be able to see and hear nonhuman primates of their own or compatible species unless the attending veterinarian determines that it would endanger their health, safety, or well-being.

(b) Environmental enrichment. The physical environment in the primary enclosures must be enriched by providing means of expressing noninjurious species-typical activities. Species differences should be considered when determining the type or methods of enrichment. Examples of environmental enrichments include providing perches, swings, mirrors, and other increased cage complexities; providing objects to manipulate; varied food items; using foraging or task-oriented feeding methods; and providing interaction with the care giver or other familiar and knowledgeable person consistent with personnel safety precautions.

(c) Special considerations. Certain nonhuman primates must be provided special attention regarding enhancement of their environment, based on the needs of the individual species and in accordance with the instructions of the attending veterinarian. Nonhuman primates requiring special attention are the following:

(1) Infants and young juveniles;

(2) Those that show signs of being in psychological distress through behavior or appearance;

(3) Those used in research for which the Committee-approved protocol requires restricted activity;

(4) Individually housed nonhuman primates that are unable to see and hear nonhuman primates of their own or compatible species; and

(5) Great apes weighing over 110 lbs. (50 kg). Dealers, exhibitors, and research facilities must include in the environment enhancement plan special provisions for great apes weighing over 110 lbs. (50 kg), including additional opportunities to express species-typical behavior.

(d) Restraint devices. Nonhuman primates must not be maintained in restraint devices unless required for health reasons as determined by the attending veterinarian or by a research proposal approved by the Committee at research facilities. Maintenance under such restraint must be for the shortest period possible. In instances where long-term (more than 12 hours) restraint is required, the nonhuman primate must be provided the opportunity daily for unrestrained activity for at least one continuous hour during the period of restraint, unless continuous restraint is required by the research proposal approved by the Committee at research facilities.

(e) Exemptions. (1) The attending veterinarian may exempt an individual nonhuman primate from participation in the environment enhancement plan because of its health or condition, or in consideration of its well-being. The basis of the exemption must be recorded by the attending veterinarian for each exempted nonhuman primate. Unless the basis for the exemption is a permanent condition, the exemption must be reviewed at least every 30 days by the attending veterinarian.

(2) For a research facility, the Committee may exempt an individual nonhuman primate from participation in some or all of the otherwise required environment enhancement plans for scientific reasons set forth in the research proposal. The basis of the exemption shall be documented in the approved proposal and must be reviewed at appropriate intervals as determined by the Committee, but not less than annually.

(3) Records of any exemptions must be maintained by the dealer, exhibitor, or research facility and must be made available to USDA officials or officials of any pertinent funding Federal agency upon request.

(Approved by the Office of Management and Budget under control number 0579-0093)

Guide for the Care and Use of Laboratory Animals

National Research Council (1996). *Guide for the Care and Use of Laboratory Animals*. National Academy Press: Washington, D.C., 127p.

Animal Environment, Housing and Management

Proper housing and management of animal facilities are essential to animal well-being, to the quality of research data and teaching or testing programs in which animals are used, and to the health and safety of personnel. A good management program provides the environment, housing,

and care that permit animals to grow, mature, reproduce, and maintain good health; provides for their well-being; and minimizes variations that can affect research results. Specific operating practices depend on many factors that are peculiar to individual institutions and situations. Well-trained and motivated personnel can often ensure high-quality animal care, even in institutions with less than optimal physical plants or equipment.

Many factors should be considered in planning for adequate and appropriate physical and social environment, housing, space, and management. These include

1. The species, strain, and breed of the animal and individual characteristics, such as sex, age, size, behavior, experiences, and health.
2. The ability of the animals to form social groups with conspecifics through sight, smell, and possibly contact, whether the animals are maintained singly or in groups.
3. The design and construction of housing.
4. The availability or suitability of enrichments.
5. The project goals and experimental design (e.g., production, breeding, research, testing, and teaching).
6. The intensity of animal manipulation and invasiveness of the procedures conducted.
7. The presence of hazardous or disease-causing materials.
8. The duration of the holding period.

Animals should be housed with a goal of maximizing species-specific behaviors and minimizing stress-induced behaviors. For social species, this normally requires housing in compatible pairs or groups. A strategy for achieving desired housing should be developed by animal-care personnel with review and approval by the IACUC. Decisions by the IACUC in consultation with the investigator and veterinarian, should be aimed at achieving high standards for professional and husbandry practices considered appropriate for the health and well-being of the species and consistent with the research objectives. After the decision-making process, objective assessments should be made to substantiate the adequacy of animal environment, husbandry, and management.

The environment in which animals are maintained should be appropriate to the species, its life history, and its intended use. For some species, it might be appropriate to approximate the natural environment for breeding and maintenance. (Chapter 2, pages 21-22)

Naturalistic Environments

Areas like pastures and islands afford opportunities to provide a suitable environment for maintaining or producing animals and for some types of research. Their use results in the loss of

some control over nutrition, health care and surveillance, and pedigree management. These limitations should be balanced against the benefits of having the animals live in more natural conditions. Animals should be added to, removed from, and returned to social groups in this setting with appropriate consideration of the effects on the individual animals and on the group. Adequate supplies of food, fresh water, and natural or constructed shelter should be ensured. (Chapter 2, page 25)

Structural Environment

The structural environment consists of components of the primary enclosure-cage furniture, equipment for environmental enrichment, objects for manipulation by the animals, and cage complexities. Depending on the animal species and use, the structural environment should include resting boards, shelves or perches, toys, foraging devices, nesting materials, tunnels, swings, or other objects that increase opportunities for the expression of species-typical postures and activities and enhance the animals' well-being. Much has been learned in recent years about the natural history and environmental needs of many animals, but continuing research into those environments that enhance the well-being of research animals is encouraged. Selected publications that describe enrichment strategies for common laboratory animal species are listed in Appendix A and in bibliographies prepared by the Animal Welfare Information Center (AWIC 1992; NRC In press).

Social Environment

Consideration should be given to an animal's social needs. The social environment usually involves physical contact and communication among members of the same species (conspecifics), although it can include noncontact communication among individuals through visual, auditory, and olfactory signals. When it is appropriate and compatible with the protocol, social animals should be housed in physical contact with conspecifics. For example, grouping of social primates or canids is often beneficial to them if groups comprise compatible individuals. Appropriate social interactions among conspecifics are essential for normal development in many species. A social companion might buffer the effects of a stressful situation (Gust and others 1994), reduce behavioral abnormality (Reinhardt and others 1988, 1989), increase opportunities for exercise (Whary and others 1993), and expand species-typical behavior and cognitive stimulation. Such factors as population density, ability to disperse, initial familiarity among animals, and social rank should be evaluated when animals are being grouped (Borer and others 1988; Diamond and others 1987; Drickamer 1977; Harvey and Chevins 1987; Ortiz and others 1985; Vandenbergh 1986, 1989). In selecting a suitable social environment, attention should be given to whether the animals are naturally territorial or communal and whether they should be

housed singly, in pairs, or in groups. An understanding of species-typical natural social behavior will facilitate successful social housing.

However, not all members of a social species can or should be maintained socially; experimental, health, and behavioral reasons might preclude a successful outcome of this kind of housing. Social housing can increase the likelihood of animal wounds due to fighting (Bayne and others 1995), increase susceptibility to such metabolic disorders as atherosclerosis (Kaplan and others 1982), and alter behavior and physiologic functions (Bernstein 1964; Bernstein and others 1974a,b). In addition, differences between sexes in compatibility have been observed in various species (Crockett and others 1994; Grant and Macintosh 1963; Vandenbergh 1971; vom Saal 1984). These risks of social housing are greatly reduced if the animals are socially compatible and the social unit is stable.

It is desirable that social animals be housed in groups; however, when they must be housed alone, other forms of enrichment should be provided to compensate for the absence of other animals, such as safe and positive interaction with the care staff and enrichment of the structural environment. (Chapter 2, pages 36-38)

Animal Behavior Research Findings Facilitate Comprehensive Captive Animal Care: The Birth of Behavioral Management

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Short title: Behavioral management and captive care

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During the past several decades there has been an explosive increase in animal behavior research in captive and wild animal populations. This growing body of scientific investigation expands the understanding of basic principles underlying animal behavior relative to biology, psychology, ecology, and natural history. As scientific research reveals increasing detail about the mechanisms influencing and driving animal behavior, the ability to appropriately manage and enhance the captive animal experience is opened to more possibilities and options including the area of animal well-being. In fact, this expanding informational resource is being applied today by a new breed of experts, Animal Behavior Managers, found working worldwide in facilities such as zoos, animal breeding colonies, and biomedical research institutions.

What prompted this shift from scientific discovery to applied principles of animal management? Some would consider the passage of welfare legislation (AWA, 1985) to be a defining moment for the regulatory acceptance and application of animal behavior research findings. While this legislation formally codified the idea of environmental enhancement and introduced the phrase 'psychological well-being', the concept had already been described in the 1972 and 1985 editions of The Guide for the Care and Use of Laboratory Animals (*The Guide*) and was likely the influence for later legislation. The *Guide*, published by the National Research Council through the Institute for Laboratory Animal Resources and the National Institutes of Health, is intended "to assist scientific institutes in providing professionally appropriate care for laboratory animals." Proper management is defined in the 1972 *Guide* as "any system of housing and care that permits animals to grow, mature, reproduce, or *behave normally*, and to be maintained in physical comfort and good health." Elsewhere in the 1972 edition, the term psychological well-being was utilized relative to physical activity and exercise. Revisions to the 1985 *Guide* include the recommendation that 'consideration be given to enriching the environment'. The term Behavioral Management also first appeared in the same edition and describes various ways to promote well being by providing social opportunities, structural complexities, and stimulating activities for captive animals. These regulations and guidelines responded to behavior goals for achieving psychological well-being using environmental enhancements in addition to the traditional clinical, husbandry, and design aspects of captive animal management.

From Environment Based to Behavior Based Terminology

Markowitz (1974; 1978) proposed a term *Behavioral Engineering* to describe changes in zoo collection management to expand the range and expression of natural behavior of the animals and thereby improve the animals' well-being. These changes included implementing naturalistic feeding, problem-solving, and locomotor challenges for the animals. As a result of Markowitz's

innovations, animals began to engage in more species typical behavior. This allowed zoo animal managers to improve the visual, auditory, and learning experience of the zoo visitors, while stimulating and enriching the captive animals. Although it appeared to be a win-win situation his concept initially met with limited acceptance from the zoological community, likely due to the terminology. Zoo professionals were concerned that *Behavioral Engineering* terminology meant engineering the animal's behavior rather than engineering environments that improved the animal's well being (Markowitz, 1982; Markowitz, personal communication, 2006).

Similarly, the term *Environmental Enrichment* has experienced difficulties since its inception. Newberry (1995) describes some of the problems associated with this term. The difficulty with the '*EE*' terminology is due to a limited number of scientifically guided assessments of enrichment techniques or procedures and hard evidence regarding effectiveness in actual use. The "*EE*" catch phrase came to include any implementation of changes in the captive animal's space regardless of the overall impact. Even though enrichment plans evolved out of the Animal Welfare Regulation mandate to "enhance the environment" those plans dedicated solely to enriching the animal's physical environment often fell short of desired behavioral outcomes due to individual animal social and housing needs, rearing history, biology, genetic makeup, developmental life stage, and experimental stressors.

A number of approaches focused more on structured activities such as individual animal training, socialization, and dietary diversity, to meet the needs of individual animals and researchers. Plans have been referred to as *Behavioral Performance Plans* (Swaisgood, & Sheperdson, 2005), *Refined Husbandry and Management Plans*, (Rice, 1994), *Clinical Ethology Plans* (Ladewig, 2005), *Wildlife Management Plans for the Laboratory* (Bayne, 1995), *Interdisciplinary Approaches* (Lund et al., 2006), *Cooperative Approaches* (Reinhardt & Cowley, 1990; Vertein & Reinhardt, 1989), and *Time Management Plans* (Schwammer, 1997), just to name a few.

Approaches differed in their attention toward individual animal needs. Treatment and prevention of individual behavior problems varied widely, as did performance training of animals relative to implementation of specific research protocols. While some environments allowed for expression of species normative behavior in captivity, others did not. Variation in terminology and focus very likely corresponded to variation in behavioral results. Animal responses to routine and standardized enrichment techniques have been wide-ranging, at times unanticipated, and even counter intuitive to popular belief (cf. Line et al., 1990; Markowitz & Timmel, 2005; Morgan et al., 1998).

Observing these diverse responses offered a much needed opportunity for reevaluating the systematic approach required to achieve well-being. Reviews by Bloomsmith & Else, 2005; Kulpa-Eddy et al., 2005; and Lutz & Novak, 2005, provide a historical perspective on the evolution of enrichment programs for animals with particular attention to programs for nonhuman

primates. This lack of standardized enrichment implementation and diversity of outcomes most likely led to the widespread use of the more popular *Behavioral Management* terminology.

From Technically Based to Scientifically Based Enrichment

It is also likely that transitioning from the most prevalent term *Environmental Enrichment* to the less familiar *Behavioral Management* required a common purpose to gain acceptance. Use of the term *Behavioral Management* suggests a broader program scope regardless of whether it is implicitly or explicitly stated in any formal documentation (Rice et al., 2002). There also seems to be a general consensus from the literature that captive animal welfare programs are gradually evolving from technically based to scientifically based programs. This is a sensible transition since vast resources of scientific literature and clinically logged data continue to develop a strong foundation that allows for more comprehensive animal husbandry and clinical care programs. These advancements have taken generic environmentally based enrichment plans to a more scientific individualized animal enrichment technology based upon known relationships between the animal's environment, from birth to maturity, and its overall behavior profile.

Although scientifically based assessments of enrichment programs are in their infancy (Baker et al., 2006; Bloomsmith & Else, 2005; Crockett, 1998), current behavioral management plans at zoos and in primate laboratories have successfully advanced to a point where the behavioral and clinical needs of animals in socially and physically stimulating environments are currently an integral component of the overall animal program (Bloomsmith & Else, 2005; Maple & Archibald, 1991). Collaborative programs between clinical and behavioral specialists at these facilities are becoming the standard rather than the exception. Baker et al. (2006) surveyed several laboratory and university facilities which house nonhuman primates. The focus of the survey was enrichment and behavioral management. They found that nearly half of all enrichment program managers working at primate facilities had formal training in behavior methods. The day-to-day behavioral management of the animals is increasingly tasked to individuals trained specifically in animal behavior and assessment techniques. The impetus for this change may be due in part to the concerted efforts of a few individuals who began their careers working in the zoo community and in some cases managing primate research facilities.

Gail Laule and Tim Desmond were among the first to formally document methods for enhancing the captive experience for zoo and laboratory animals, (Desmond, 1994; Laule, 1993). One individual in particular, Dr. Michale Keeling, formerly at the M.D. Anderson Cancer Center in Texas, demonstrated great foresight by adopting these behavioral management techniques to the laboratory (Keeling et al., 1991). Dr. Keeling was a program director who realized the benefits of hiring individuals with behavioral backgrounds to work in the primate laboratory at Bastrop, Texas. Keeling and his colleagues (Keeling et al., 1991) proposed a strong bias for action

regarding the management of primates and enrichment programs in laboratories. Many of those management tenets for working with nonhuman primates have become commonplace in the general laboratory and zoological community (Bloomsmith et al., 1991; Schapiro, 2000; Schapiro et al., 2003; Schapiro et al., 1994; Schapiro et al., 2005; Whittaker et al., 2001; NRC, 1998).

It is clear that the major focus of current environmental enhancement programs is more than just providing supplemental toys for animals to manipulate. This is true regardless of whether animals are housed in a research laboratory or zoological collection. The concept of behavioral management addresses questions about animal behavior as a critical and integral component of the overall health and well-being of these animals. Benefits from the efforts of dedicated animal behavior specialists working at all levels of laboratory and zoo collection management are being experienced by the animals as well as veterinarians, principal investigators, animal care staff, business office managers and the general public. Programs will continue to evolve and address well-being as more data are generated allowing improved captive animal management. The challenge for the future is to continue finding support for scientifically updating the principles and procedures of behavioral management. Markowitz and Timmel (2005) point out that there is continued reluctance from funding agencies to support needed basic research into issues relative to facility design, husbandry techniques or behavioral methods which potentially enhance animal well-being. Continued support from individuals responsible for laboratory and zoological review, accreditation, and oversight is critical to move these programs forward. This is especially true if the principles advocated by practitioners of behavioral management are to ultimately gain acceptance as the new standards of animal care.

Acknowledgments

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Descriptors: stress, laboratory animals, laboratory procedures, handling, blood collection, orogastric gavage, physiological parameters, distress, humane implications.

Bayne, K. (2005). **Potential for unintended consequences of environmental enrichment for laboratory animals and research results**. *ILAR Journal* 46(2): 129-139. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: Many aspects of the research animal's housing environment are controlled for quality and/or standardization. Of recent interest is the potential for environmental enrichment to have unexpected consequences such as unintended harm to the animal, or the introduction of variability into a study that may confound the experimental data. The effects of enrichment provided to nonhuman primates, rodents, and rabbits are described to illustrate that the effects can be numerous and may vary by strain and/or species. Examples of parameters measured where no change is detected are also included because this information provides an important counterpoint to studies that demonstrate an effect. In addition, this review of effects and noneffects serves as a reminder that the provision of enrichment should be evaluated in the context of the health of the animal and research goals on a case-by-case basis. It should also be kept in mind that the effects produced by enrichment are similar to those of other components of the animal's environment. Although it is unlikely that every possible environmental variable can be controlled both within and among research institutions, more detailed disclosure of the living environment of the subject animals in publications will allow for a better comparison of the findings and contribute to the broader knowledge base of the effects of enrichment.
Descriptors: potential harm to animals, controlling for environmental variables in research, confounding results, effects of enrichment on data, animal health, detailing the animal's living

environment in publications.

Bayne, K.A. (2003). **Environmental enrichment of nonhuman primates, dogs and rabbits used in toxicology studies**. *Toxicologic Pathology* 31(Suppl.): 132-137. ISSN: 0192-6233.
Abstract: The increasing emphasis on the provision of environmental enrichment to laboratory animals, vis-a-vis the USDA Animal Welfare Regulations, the Guide for the Care and Use of Laboratory Animals (NRC 1996), and a potential forthcoming policy from the USDA on the subject, can be difficult to accommodate in a toxicology research environment. A summary will be provided of current requirements and recommendations. Then, strategies for meeting regulatory requirements will be described for non-rodent animals used in toxicology research. These strategies will address methods of both social enrichment, such as pair or group housing, as well as non-social enrichment, such as cage furniture, food enrichments, and toys. In addition, the value of positive interactions with staff (e.g., through training paradigms or socialization programs) will also be discussed. Apparent in the discussion of these strategies will be an overarching recognition of the necessity to avoid introducing confounding variables into the research project and to avoid compromising animal health. The roles of the Institutional Animal Care and Use Committee (IACUC) and the attending veterinarian in helping scientists balance animal well-being, the scientific enterprise and the regulatory environment will be described.
Descriptors: animal husbandry, animal welfare, laboratory animals, housing, toxicology, animal welfare legislation, dogs, rabbits, social environment.

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NAL Call Number: QL55.A1I43
Abstract: Environmental enrichment for laboratory animals has come to be viewed as a potential method for improving animal well-being in addition to its original sense as a paradigm for learning how experience molds the brain. It is suggested that the term housing supplementation better describes the wide range of alterations to laboratory animal housing that has been proposed or investigated. Changes in the environments of animals have important effects on brain structure, physiology, and behavior--including recovery from illness and injury--and on which genes are expressed in various organs. Studies are reviewed that show how the brain and other organs respond to environmental change. These data warrant caution that minor cage supplementation intended for improvement of animal well-being may alter important aspects of an animal's physiology and development in a manner not easily predicted from available research. Thus, various forms of housing supplementation, although utilized or even preferred by the animals, may not enhance laboratory animal well-being and may be detrimental to the research for which the laboratory animals are used.
Descriptors: housing supplementation, environmental change, laboratory animals, brain, well-being, physiology.

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Descriptors: stress, zoo animals, animal housing, animal behavior.

Chang, F.T. and L.A. Hart (2002). **Human-animal bonds in the laboratory: How animal behavior affects the perspective of caregivers**. *ILAR Journal* 43(1): 10-18. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Descriptors: laboratory animals, dogs, mice, laboratory workers, anthropology, animal welfare, animal husbandry, training of animals, stress, enrichment, safety at work, work satisfaction, human-animal relationships, animal technicians, environmental enrichment.

Cosgrove, C. (2004). **Animal welfare and facility design**. *Animal Lab News* 3(6): 55-57.
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Descriptors: environmental enrichment, animal welfare, social behavior, public perception, biomedical research, vertical space, human contact.

Davey, G. (2006). **Relationships between exhibit naturalism, animal visibility and visitor interest in a Chinese zoo**. *Applied Animal Behaviour Science* 96(1-2): 93-102. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: wildlife management, zoo, exhibit design, visitor interest, animal visibility, China.

Davey, G., P. Henzi, and L. Higgins (2005). **The influence of environmental enrichment on Chinese visitor behavior**. *Journal of Applied Animal Welfare Science* 8(2): 131-140. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Welfare improvements for nonhuman animals should aim to satisfy the needs of visitors as well as those of the animals. Little research has been conducted, however, and existing work is confined to zoos in developed countries. This article reports the behavioral responses of Chinese visitors to environmental enrichment improvements in a zoo enclosure. Visit, viewing, and stopping behaviors significantly increased at the transformed exhibit, indicating that it provoked greater visitor interest. Furthermore, increased intragroup behaviors suggested that the exhibit probably motivated visitors to interact socially. The positive impact of the exhibit changes supports the enrichment efforts taking place in zoos around the world. The changes also provide encouragement for zoos in developing countries such as China because greater visitor interest provides a strong argument and an incentive for improving welfare standards.
Descriptors: visitor response to environmental enrichment, zoos, enrichment causes zoo visitors to interact more frequently, China, animal welfare standards.

Dean, S.W. (1999). **Environmental enrichment of laboratory animals used in regulatory toxicology studies**. *Laboratory Animals* 33(4): 309-327. ISSN: 0023-6772.
NAL Call Number: QL55.A1L3
Abstract: There is a wealth of information in the published literature which describes a multitude of approaches to enriching the environment of laboratory animals. This paper attempts to review the various methods of enrichment through social contact, enhancement of the environment and diet, and improvements in husbandry. It attempts to place the various enrichment initiatives within the context of a laboratory which conducts regulatory toxicology, describes some of the experiences in the author's own laboratory and attempts to highlight those ideas which might prove practical to implement in the future. The aim is to demonstrate that a creative approach to environmental enrichment is indeed compatible with regulatory toxicology. It is hoped that this will encourage those responsible for the care and welfare of animals in such a laboratory to challenge historical practices and include environmental enrichment as a fundamental necessity of study

design.
Descriptors: laboratory animals, cages, monkeys, foraging, enrichment, environment, dogs, group size, toys, rabbits, floor pens, rats, mice, social dominance, floor type, pelleted feeds, guinea pigs, toxicology, animal welfare, literature reviews.

Fillman Holliday, D. and M.S. Landi (2002). **Animal care best practices for regulatory testing**. *ILAR Journal* 43(Suppl.): S49-S58. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: Best practices result from a partnership between law, science, and the people working with the animals on regulated studies. In an ideal setting, people working with animals observe and study animal behavior as influenced by different housing and handling paradigms. These observations are published to create a body of science, and laws are promulgated based on the science. The ideal world does not exist, but there are certain components of best practices common to all species. These components include study design, housing, social contact, diet/feed, enrichment devices, and human interaction. This paper outlines how the forces of law, science, and people work to create best practices for species in regulated studies, specifically mice, rats, rabbits, dogs, and nonhuman primates.
Descriptors: animal husbandry, animals, laboratory physiology, laboratory animal science standards, toxicity tests methods, xenobiotics toxicity, animals, laboratory psychology, laboratory animal science methods, social environment.

Forman, J.M., L.N. Claude, A.M. Albright, and A.M. Lima (2001). **The design of enriched animal habitats from a biological engineering perspective**. *Transactions of the American Society of Agricultural Engineers* 44(5): 1363-1371. ISSN: 0001-2351.
NAL Call Number: 290.9Am32T
Abstract: Applying biological engineering principles to animal habitat design represents a paradigm shift from traditional approaches by virtue of placing the biology of the animal(s) at the center of the design process and designing a habitat around the animal(s). The objective of this article is to detail this paradigm shift, first by providing a detailed discussion on the design of enriched environments for captive animals, and then through a case study involving the transformation of a tiger cage into a tiger habitat. All habitat design elements are created based on the physical and behavioral needs of the animal.
Descriptors: zoo animals, tigers, cages, habitats, design, engineering, enrichment, animal behavior, needs assessment, basic needs, quality of life.

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NAL Call Number: QL1 .D48 v.31
Descriptors: laboratory animals, experimentation, animal welfare, animal behavior.

Goldschmidt, C. and A. Malleau (2004). **Environmental enrichment at the Toronto Zoo**. *CSAW News* Fall/Winter(12): 4-5.
Descriptors: environmental enrichment program, psychological well-being, zoo animals, animal behavior, abnormal behavior, categories of enrichment items.

Guittin, P. and T. Decelle (2002). **Future improvements and implementation of animal care practices within the animal testing regulatory environment**. *ILAR Journal* 43(Suppl.): S80-S84. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: Animal welfare is an increasingly important concern when considering biomedical experimentation. Many of the emerging regulations and guidelines specifically address animal welfare in laboratory animal care and use. The current revision of the appendix of the European Convention, ETS123 (Council of Europe), updates and improves on the current animal care

standardization in Europe. New guidelines from the Organisation for Economic Co-operation and Development and the European Federation of Pharmaceutical Industries Association focus specifically on safety testing. These guidelines will affect the way toxicity studies are conducted and therefore the global drug development process. With the 3Rs principles taken into account, consideration regarding animal welfare will demand changes in animal care practices in regulatory safety testing. The most significant future improvements in animal care and use practices are likely to be environmental enrichment, management of animal pain and distress, and improved application of the humane endpoints. Our challenge is to implement respective guidelines based on scientific data and animal welfare, through a complex interplay of regulatory objective and public opinion. The current goal is to work toward solutions that continue to provide relevant animal models for risk assessment in drug development and that are science based. In this way, future improvements in animal care and use practices can be founded on facts, scientific results, and analysis. Some of these improvements become common practice in some countries. International harmonization can facilitate the development and practical application of "best scientific practices" by the consensus development process that harmonization requires. Since the implementation of good laboratory practices (GLP) standards in safety testing, these new regulations and recommendations represent a new way forward for animal safety studies.
Descriptors: animal husbandry, animal welfare, laboratory animals, legislation and regulation, prevention and control of pain, social environment, toxicity tests.

Hawkins, P. (2002). **Recognizing and assessing pain, suffering and distress in laboratory animals: a survey of current practice in the UK with recommendations**. *Laboratory Animals* 36(4): 378-395. ISSN: 0023-6772.
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NAL Call Number: QL55.A1L3
Descriptors: animal welfare, recognizing and assessing pain, suffering, and distress, laboratory animals, survey review, techniques to reduce suffering, humane endpoints, refining husbandry, analgesia, United Kingdom Animals (Scientific Procedures) Act 1986.

Hawkins, P., D.B. Morton, R. Bevan, K. Heath, J. Kirkwood, P. Pearce, L. Scott, G. Whelan, A. Webb, and Joint Working Group on Refinement (2004). **Husbandry refinements for rats, mice, dogs and non-human primates used in telemetry procedures. Seventh report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement, Part B.** *Laboratory Animals* 38(1): 1-10. ISSN: 0023-6772.
NAL Call Number: QL55.A1L3
Descriptors: animal husbandry, dogs, mice, primates, rats, telemetry, animal welfare, surgery.

Hepper, P.G. and D.L. Wells (2004). **Enrichment is not always enriching**. *Animal Welfare* 13(Suppl.): S243. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: environmental enrichment, animal behavior, open field test, animal welfare, social enrichment.

Hosey, G.R. (2000). **Zoo animals and their human audiences: What is the visitor effect.** *Animal Welfare* 9(4): 343-357. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: zoo animals, primates, visitor behavior, animal behavior, stress, group interaction, enrichment, animal housing, animal welfare, literature reviews.

Hutchinson, J.M.C. (2005). **Is more choice always desirable? Evidence and arguments from leks, food selection, and environmental enrichment**. *Biological Reviews* 80(1): 73-92. ISSN: 1464-7931.
Descriptors: behavioral ecology, computational models, simulation, enrichment, food selection, lekking behavior.

Kuehn, B.M. (2002). **Zoo animal welfare boosted by environmental enrichment, positive**

reinforcement training. *Journal of the American Veterinary Medical Association* 221(11): 1532. ISSN: 0003-1488.
NAL Call Number: 41.8 Am3
Descriptors: effects of captivity, animal well-being, protected contact, social interactions, desensitization, enrichment strategies, training of animals.

Kulpa Eddy, J.A., S. Taylor, and K.M. Adams (2005). **USDA perspective on environmental enrichment for animals**. *ILAR Journal* 46(2): 83-94. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: This article provides a brief historical background of the events and circumstances that led to the 1985 Animal Welfare Act (AWA) amendments. It describes the development of the regulations promulgated by the US Department of Agriculture (USDA) in 1991 as a result of these amendments, the reasoning given for the proposals, and the revisions that were made during the process. Information is included on USDA implementation of the regulations regarding exercise for dogs and environmental enhancement for nonhuman primates. Also mentioned briefly are the requirements for socialization of marine mammals and space requirements for certain other regulated warm-blooded species. These requirements apply to animal dealers (breeders and brokers), exhibitors, commercial transporters, and research facilities. The standards for exercise and environmental enhancement were different from any others previously contained in the AWA regulations, and required more research and understanding of species-specific needs by the regulated community. Finally, this article describes some of the initiatives being undertaken by the research community and USDA-Animal and Plant Health Inspection Services (APHIS)-Animal Care to provide the necessary education and guidance indicated by the violation history data.
Descriptors: Animal Welfare Act, regulated facilities, United States of America, standards for exercise for dogs, environmental enhancement for nonhuman primates, U.S. Department of Agriculture.

Lindley, A. (2004). **Environmental Enrichment for Captive Animals: Young, R.J.** *The Veterinary Journal* 168(2): 173. ISSN: 1090-0233.
NAL Call Number: SF601.V484
Abstract: This article is a review of a new book by R.J. Young called *Environmental Enrichment for Captive Animals*. The book was published by Blackwell Publishing, Oxford in 2003 (240 pp.; ISBN: 0632064072)
Descriptors: book review, content description, environmental enrichment.

Luyster, J.S. (2003). **Enrichment as a behavioral modification tool in the zoo hospital setting**. *Animal Keepers' Forum* 30(5): 196-200. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: zoo hospitals, environmental enrichment programs, care in captivity, behavioral modification, animals in captivity.

Mellen, J. and M.S. MacPhee (2001). **Philosophy of environmental enrichment: Past, present, and future.** *Zoo Biology* 20(3): 211-226. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: zoo animals, animal welfare, environmental enrichment, animal husbandry, animal behavior, reproductive performance, stress, captive habitats.

Morimura, N. (2000). **Psychological well-being of captive animals.** *Japanese Journal of Animal Psychology* 50(1): 183-191. ISSN: 0916-8419.
Descriptors: U.S. Animal Welfare Act, environmental enrichment, natural behavior, husbandry improvements, selectability and controllability of the environment, evaluation of enrichment program.

Narushima, E. (2001). **Environmental enrichment for geriatric animals in zoos**. *Journal of Veterinary Medicine, Japan* 54(11): 935-941. ISSN: 0447-0192.
Descriptors: captive environment, geriatric animals, animals in zoos, environmental enrichment

programs.

Olsson, I.A.S., C.M. Nevison, E.G. Patterson Kane, C.M. Sherwin, H.A. Van de Weerd, and H. Wurbel (2003). **Understanding behaviour: The relevance of ethological approaches in laboratory animal science**. *Applied Animal Behaviour Science* 81(3): 245-264 . ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: mice, rats, laboratory animals, animal behavior, strain differences, animal housing, cages, environmental enrichment, smell, vision, hearing, taste, touch, validity.

Ottesen, J.L., A. Weber, H. Gurtler, and L.F. Mikkelsen (2004). **New housing conditions: Improving the welfare of experimental animals**. *Alternatives to Laboratory Animals* 32(Suppl. 1B): 397-404. ISSN: 0261-1929.
NAL Call Number: Z7994.L3A5
Abstract: As animal experiments and testing are still a necessary part of the discovery and development of new drugs and do not seem likely to be totally replaced in the foreseeable future, it is important that the care and use of these animals are continuously refined. Since the housing facilities are where most experimental animals spend the major part of their lives, this area should be given special attention to ensure optimal welfare for the animals. in a unique collaboration between a pharmaceutical company and an animal welfare organisation, the housing conditions of mice, rats, guinea-pigs, rabbits and dogs, respectively, were reviewed with focus on the basic needs of the animals. Prototypes for new housing systems satisfying the most important of these basic needs of the animals were developed, with valuable input from international experts with special knowledge of the behaviour of experimental animals. These new housing systems and species-specific, newly introduced socialisation programmes contribute to improved animal welfare and a better occupational health of the animal caretakers. Since these new housing systems are more pleasant and appealing, they may also have the added benefit that they contribute to a broader public acceptance of the use of experimental animals.
Descriptors: animals in laboratories, housing systems, animal testing, socialization programs, drug development in research, public appeal, addressing basic needs of animals.

Purchase, I.F.H. and M. Nedeva (2003). **The impact of the ethical review process for research using animals in the UK: Attitudes to animal welfare by those working under the Animals (Procedures) Act 1986**. *Animal Technology and Welfare* 2(2): 77-84. ISSN: 0264-4754.
NAL Call Number: SF757.A62
Descriptors: laboratory animals, animal law, animal use alternatives, animal welfare, animal use refinement, animal care, environmental enrichment, questionnaires, researchers, United Kingdom.

Rabin, L.A. (2002). **Maintaining behavioural diversity in captivity for conservation: natural behaviour management**. *Animal Welfare* 12(1): 85-94. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: predator-prey interactions, animal welfare, captivity, natural behavior management, behavioral diversity, environmental enrichment strategies.

Reinhardt, V. and A. Reinhardt (2001). **Legal space requirement stipulations for animals in the laboratory: are they adequate?** *Journal of Applied Animal Welfare Science* 4(2): 143-149. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: animal experiments, cage size, floor space, laboratory animals, space requirements, Animal Welfare Act.

Rice, T.R., S. Walden, G.E. Laule, and G.A. Heidbrink (2002). **Behavioral management: It's everyone's job**. *Contemporary Topics in Laboratory Animal Science* 41(4): 58-62. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: In this day and age of regulatory demands and with the ever-increasing flow of environmental enhancement data and opinions, it can become very confusing for animal

programs to create and maintain a successful behavioral management program. Behavioral management as a concept provides a common ground from which animal facilities may start to build a successful facility behavioral program. In addition, the implementation of a behavioral management program can help to break down barriers between members of the various disciplines within the biomedical community. It is everyone's responsibility and duty to work together with this common goal: to provide the best care and environment we can for the animals in our charge. Working together to improve animal behavior can help us to achieve this goal.
Descriptors: animals in laboratories, behavioral management, enrichment, animal care, cooperation of animal facility staff, animal behavior.

Rübel, A. (1999). **Behavioural enrichment at Zürich Zoo - How we give the animals back their true nature**. *KTBL Schrift* (No. 382): 42-48. ISSN: 0173-2811.
Descriptors: zoo animals, animal behavior, animal housing, environmental enrichment, Switzerland.

Shepherdson, D. (2002). **Realizing the vision: Improving zoo animal environments through enrichment**. *AZA Communique* (June): 5-6.
Online: http://www.aza.org/Publications/2002/06/June2002VTS.pdf | (520 KB)
NAL Call Number: QL1 .A44
Descriptors: environmental enrichment, historical background, American Zoo and Aquarium Association Behavior Advisory Group, enrichment definition.

Shepherdson, D.J. (2003). **Environmental enrichment: Past, present and future**. *International Zoo Yearbook* 38: 118-124. ISSN: 0074-9664.
NAL Call Number: QL76.I5
Descriptors: enrichment concepts, animal keeper enthusiasm, animal welfare, zoo animals, husbandry routines.

Stewart, K.L. (2003). **Environmental enrichment program development: Hurdling the common obstacles**. *Animal Technology and Welfare* 2(1): 9-12. ISSN: 0264-4754.
NAL Call Number: SF757.A62
Descriptors: animal well-being, psychological enrichment, animal housing, budget, personnel, experimental design, engineering standards.

Stewart, K.L. and K. Bayne (2004). **Environmental enrichment for laboratory animals**. In: J.D. Reuter and M.A. Suckow (Editors), *Laboratory Animal Medicine and Management,* International Veterinary Information Service: Ithaca, New York, USA, online.
Online: http://www.ivis.org/advances/Reuter/stewart/ivis.pdf (276 KB)
Descriptors: environmental enrichment, program development, regulations, guidelines, species-specific behavior, social enrichment, non-social enrichment, providing opportunity for control in the environment.

Stewart, K.L. and S.S. Raje (2001). **Environmental enrichment committee: Its role in program development**. *Lab Animal* 30(8): 50-2. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: The authors discuss the role of the Environmental Enrichment Committee in developing, implementing, assessing, and modifying a university animal enrichment program.
Descriptors: animal welfare, guidelines, housing, animal, environment, Indiana, organizational policy, program development, universities.

Turner, P.V., K.L. Smiler, M. Hargaden, and M.A. Koch (2003). **Refinements in the care and use of animals in toxicology studies - Regulation, validation, and progress**. *Contemporary Topics in Laboratory Animal Science* 42(6): 8-15. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: laboratory animals, rats, cynomolgus macaques, toxicity testing, blood, health issues, environmental enrichment.

Van de Berg, J.L. and W.H. Stone (2002). **The future of animal research**. *ILAR Journal* 43(2): 110-113. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Descriptors: animal welfare, genetically modified animals, laboratory animals, cloning, primates, public policy, research trends, rodents.

Weekley, L.B., P. Guittin, and G. Chamberland (2002). **The international symposium on regulatory testing and animal welfare: Recommendations on best scientific practices for safety evaluation using nonrodent species.** *ILAR Journal* 43(Suppl.): S118-S122. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Descriptors: animal testing alternatives, animal welfare, laboratory animals, government regulation, toxicity tests, *Callithrix*, dogs, health planning guidelines, international cooperation, *Macaca*, swine.

White, B.C., L.A. Houser, J.A. Fuller, S. Taylor, and J.L.L. Elliott (2003). **Activity-based exhibition of five mammalian species: evaluation of behavioral changes.** *Zoo Biology* 22(3): 269-285. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: animal behavior, activity levels, stereotypic behavior, natural behavior, use of space, husbandry management, orangutans, siamangs, tapirs, babirusa, tigers.

Wolfle, T.L. (2005). **Introduction: Environmental enrichment**. *ILAR Journal* 46(2): 79-82. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Descriptors: effect on scientific outcomes, animal well-being, Animal Welfare Act, federal requirements, facility design, potential for negative consequences, rodents, rabbits, dogs, nonhuman primates, developing enrichment programs, United States of America.

Yoshida, H. (2000). **A report about the present situation of American zoos' efforts for the environment enrichment for animals - at the Enrichment Workshop in Columbus Zoo**. *Primate Research* 16(1): 45-53. ISSN: 0912-4047.
Descriptors: animal housing, enrichment, report of workshop, Columbus Zoo.

General Primate Enrichment

Agoramoorthy, G. and S. Alagappasamy (2004). **Management of endangered Asian primates in Singapore Zoo: Welfare, enrichment and conservation implications**. *Folia Primatologica* 75(Suppl. 1): 214. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: environmental enrichment, animal welfare, colony management, Singapore Zoo, meeting abstract.
Notes: Spring Meeting of the Primate Society of Great Britain, St Andrews, Scotland; April 10-11, 2003.

Agoramoorthy, G. and M. Hsu (2004). **Welfare, enrichment and conservation of non-human primates in zoological parks.** *Folia Primatologica* 75(Suppl. 1): 211-212. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: colony management, environmental enrichment, zoos, meeting abstract.
Notes: Spring Meeting of the Primate Society of Great Britain, St Andrews, Scotland; April 10-11, 2003.

Anonymous (1999). **USDA seeks comments on environmental enhancement for nonhuman primates**. *Journal of the American Veterinary Medical Association* 215(4): 466. ISSN: 0003-1488.
NAL Call Number: 41.8 Am3
Descriptors: United States Animal Welfare Act, care of primates, captive animals, environmental enrichment, psychological well-being.

Baker, K.C. (2000). **Environmental enhancement: Policy, plans, and perspective.** *American Journal of Primatology* 51(Suppl. 1): 35-36. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: animal care, government and law, captive management, enrichment plans, meeting abstract.
Notes: 23rd Annual Meeting of The American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Baker, K.C. and D.A. Springer (2006). **Frequency of feeding enrichment and response of laboratory nonhuman primates to unfamiliar people.** *Journal of the American Association for Laboratory Animal Science* 45(1): 69-73. ISSN: 1559-6109.
NAL Call Number: 41.8 Am3
Abstract: Although environmental enhancement plans for nonhuman primates vary between facilities, feeding enrichment represents a component of most programs. As part of a facility's feeding enrichment program, offering hand-fed food items by trained staff provides an opportunity for positive human interaction. We hypothesized that increased implementation of such enrichment would be associated with increased likelihood of a monkey accepting a hand-fed treat from a stranger. Several species of monkeys were tested at the Tulane National Primate Research Center. In 2002 and 2005, we recorded the number of caged monkeys that accepted a treat tablet from an unfamiliar person within 10 s. We compared the frequency of caretaker-implemented feeding enrichment documented for each animal room during the month proceeding data collection with the proportion of animals within the room that accepted the treat from the stranger. In 2002, 29.8% of the 500 subjects accepted the treat from the unfamiliar person. The proportion of animals that accepted the treat was significantly correlated with the number of days during which feeding enrichment had been implemented. In 2005, feeding enrichment frequency had increased by 76%, and 53.4% of the 676 subjects accepted the treat. These findings suggest that this simple form of enrichment may improve monkeys' responses to unfamiliar people, and that it holds promise as a method for mediating the stress imposed by human activity in animal rooms. In addition, a stranger's treat-feeding attempts may be a useful indicator of an institution's

implementation of their environmental enrichment program.
Descriptors: feeding behavior, feeding methods, animal welfare, animal behavior, environmental enhancement, feeding enrichment, treats, positive human interaction, enrichment programs.

Bassett, L. (2000). **The benefits of social enrichment for zoo-housed primates**. In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 53-62.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: mandrills, *Mandrillus sphinx*, animal welfare, wild animals in captivity, zoo settings, social housing, effects of group size on the behavior, activity budgets, enrichment by increasing group size, European Zoos.

Bonnet, L., F. Bellebeau, G. Briday, M. Gregoire, B. Regnier, and J. Descotes (2004). **Socialisation of non-human primates in regulatory toxicity studies in compliance with the new European guidelines**. *Toxicology and Applied Pharmacology* 197(3): 244-245. ISSN: 0041-008X.
Descriptors: environmental enrichment, experimental psychology, toxicology, colony management, European Union, meeting abstract.
Notes: Living in a Safe Chemical World: The 10th International Congress of Toxicology, Tampere, Finland; July 11-16, 2004.

Bonnotte, S. (1999). **Promouvoir le bien-etre psychologique des primates captifs et de laboratoire: aspects theoriques et pratiques (Apports de la recherche sur l' enrichissement du milieu a la promotion du bien-etre des primates captifs). [Promoting psychological well-being of captive and laboratory human primates: theoritical and practical aspects (Contribution of environmental enrichment research in the promotion of captive primate well-being)]**. *Revue De Medecine Veterinaire* 150(1): 15-26. ISSN: 0035-1555.
NAL Call Number: 41.8 R32
Descriptors: nonhuman primates, captivity, laboratory animals, animal well-being, behavior, environmental factors.
Language of Text: French; Summary in English.

Brown, M.T. (2005). **Mature primate enrichment**. *The Shape of Enrichment* 14(1): 4-6. ISSN: 1088-8152.
NAL Call Number: HV4737.S53
Descriptors: adult nonhuman primates, treat cups, flavored shave ice, essential oils, nature cubes, rain sticks, environmental enrichment ideas.

Cocks, L., C. Baker, G. Harris, and F. Butcher (1999). **Behavioral enrichment for nonhuman primates**. *Laboratory Primate Newsletter* 38(1): 14-15. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn38-1.html
NAL Call Number: SF407.P7 L3
Descriptors: behavioral enrichment, Australia, social environment, foraging enrichment, complex environment, indestructible toys, destructible toys, positive reinforcement training.

Craig, J. and C. Reed (2003). **Diet-based enrichment ideas for small primates**. *International Zoo News* 50(1): 16-20; No 322. ISSN: 0020-9155.
NAL Call Number: QL76.I58
Descriptors: primates, diet in captivity, environmental enrichment,foraging.

Crockett, C.M., R.U. Bellanca, K.S. Heffernan, and D.C. Johnson (1999). **A psychological well-being program for managing environmental enrichment and behavior issues in a colony of research primates**. *American Journal of Primatology* 49(1): 46-47. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: estimate of well-being, enrichment, colony management, animal welfare, meeting

abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, Tulane University, New Orleans, USA; August 12-16, 1999.

Crockett, C.M., R.U. Bellanca, K.S. Heffernan, D.A. Ronan, and W.F. Bonn (2001). **Puzzle Ball foraging device for laboratory monkeys.** *Laboratory Primate Newsletter* 40(1): 4-7. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn40-1.html
NAL Call Number: SF407.P7 L3
Descriptors: puzzle feeder, foraging device, stainless steel, Boomer Ball, effect of puzzle ball on abnormal behavior, animal behavior, psychological well-being, environmental enrichment.

Crockett, C.M., R.U. Bellanca, D.R. Koberstein, D. Rocha, G.J. Bennett, Z.M. Hoffman, and T. Olson (2003). **Essential involvement in husbandry staff in a National Primate Research Center's psychological well-being program.** *Contemporary Topics in Laboratory Animal Science* 42(4): 70. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: environmental enrichment, colony management, staff involvement, legal requirements, estimate of well-being, meeting abstract.

de Rosa, C., A. Vitale, and M. Puopolo. (2000). **Environmental enrichment for nonhuman primates: An experimental approach.** In: *Progress in the Reduction, Refinement and Replacement of Animal Experimentation: Proceedings of the 3rd World Congress on Alternatives and Animal Use in the Life Sciences, August 29-September 2, 1999, Bologna, Italy,* Elsevier Science: Amsterdam, Netherlands, p. 1295-1304. ISBN: 0444505296.
Descriptors: age effects, enriched environment, feed dispensers, social behavior.

DeHaven, W.R. (2000). **USDA's environmental enhancement plans for NHPs: Ensuring the best care possible.** *Lab Animal* 29(1): 44-46. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Descriptors: laboratory animals, nonhuman primates, enrichment, social environment, restraint of animals, legislation, USDA Animal and Plant Health Inspection Service, Animal Welfare Act.

Dennis, J., M. Hug-Williams, and A. Bowkett. (2000). **Development of a comprehensive enrichment programme in an ageing monkey house.** In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 119.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: 15 species of nonhuman primates, zoo setting, effectiveness of enrichment methods, browse, foraging enrichment, hammocks, hiding food, mirrors, puzzle feeders, testing new enrichment methods, meeting abstract.

Farrand, A. and H. Buchanan-Smith (2004). **Integrating zoo visitors into olfactory enrichment programmes for captive primates.** *Folia Primatologica* 75(Suppl. 1): 373-374. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: sense of smell, olfaction, prosimians, new world monkeys, animal welfare, zoos, meeting abstract.
Notes: 20th Congress of the International Primatological Society, Torino, Italy; August 22-28, 2004.

Hall, C. (2004). **Primate enrichment.** *Ratel* 31(2): 10-11. ISSN: 0305-1218.
NAL Call Number: QL77.5.R37
Descriptors: zoos, environmental enrichment, *Hylobates*, *Erythrocebus*, *Cercopithecus*, *Brachyteles*, *Cebidae*, *Anthropoidea*.

Hau, J. (2004). **The refinement of primate models for biomedical research.** *Folia Primatologica*

75(Suppl. 1): 132. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: environmental enrichment, animal training, behavioral methods, animal welfare, restraint, handling, stress, meeting abstract.
Notes: 20th Congress of the International Primatological Society, Torino, Italy; August 22-28, 2004.

Hau, J.S.S.J. (2004). **The welfare of non-human primates**. In: E. Kaliste (Editor), *Welfare of Laboratory Animals,* Kluwer Academic Publ: Dordrecht, p. 291-314. ISBN: 1402022700.
Descriptors: stress, animal welfare, colony management, operant conditioning, cage design, enrichment, blood collection.

Hill, L.R. and G.A. Ambrose (2003). **A simple, inexpensive method to minimize floor drain obstructions while supporting environmental enrichment in primate facilities**. *Contemporary Topics in Laboratory Animal Science* 42(6): 42-45. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: An important component of nonhuman primate environmental enrichment programs is affording the animals the opportunity to manipulate objects. Although these objects and various bulky food items enrich the quality of life for nonhuman primates, they complicate the duties of facility maintenance personnel. A prime example of these sometimes costly complications is a seemingly never-ending series of floor drain obstructions. We devised a simple, inexpensive modified drain cover that prevents large items from entering the drain. The total cost of materials for this device was 1.12 dollars, and it required only 15 min of labor for assembly. The design and implementation of this modified drain cover illustrate why the interaction between physical-plant personnel and animal-care personnel is key to the operation of a successful animal care and use program and proper maintenance of laboratory animal facilities.
Descriptors: object manipulation, husbandry, cost of enrichment, animal welfare, animal housing, facility design, animal care staff, safety.

Honess, P.E. and C.M. Marin (2006). **Behavioral and physiological aspects of stress and aggression in nonhuman primates**. *Neuroscience and Biobehavioral Reviews* 30(3): 390-412. ISSN: 0149-7634.
Descriptors: aggressive behavior, stress, social isolation, group formation, crowding, social status, temperament, age and gender effects, literature review.

Hopper, K.J. and J.T. Newsome (2004). **Proactive compliance-the team program approach to revitalizing primate enrichment**. *Contemporary Topics in Laboratory Animal Science* 43(2): 37-38. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: The Division of Laboratory Animal Resources (DLAR) at the University of Pittsburgh proactively instituted a nonhuman enrichment plan that is founded on the United States Department of Agriculture (USDA) Final Report on the Environmental Enhancement to Promote the Psychological Well-being of Nonhuman Primates (July 1999). This document is a draft policy of the USDA that has not yet been enacted. In anticipation of the these standards becoming policy, the DLAR, and our Institutional Animal Care and Use Committee (IACUC), primate user groups, and Enrichment Specialist compared these new standards to our previous IACUC-approved plan. Our goal was to be "proactively compliant" to anticipated policy changes described in The Final Report. We established a program that was consistent with the five "critical" elements of The Final Report and our goal to have a revitalized enrichment plan that applied internal evaluation for continued improvement. A task force was implemented to review current literature and regulations on enrichment. Then a subcommittee consisting of veterinarians, investigators whose research would be affected by the anticipated policy changes, and IACUC members was formed. They established criteria for dispensation from plan elements, brought current protocols into compliance, shared enrichment and documentation techniques, and considered research methods in decision-making. In addition, a primate Enrichment Specialist position was developed and recruited. The Enrichment Specialist worked with

investigators to evaluate enrichment and documentation needs and organized and implemented plan structure. The DLAR staff provided animal care and veterinary insight and reported to the IACUC. Investigators discussed how research and enrichment affected each other. The IACUC considered these issues before approving the plan. Our revitalized plan is running smoothly. The Enrichment Specialist oversees plan implementation and documentation. The DLAR assists enrichment and animal assessment. Investigators assist with assessment, provide enhanced enrichment, and document their progress. The IACUC addresses dispensation requests through designated review on the large-animal subcommittee.
Descriptors: animal husbandry, environmental enrichment plan, Institutional Animal Care and Use Committees (IACUC), USDA draft policy on enrichment for nonhuman primates, five critical elements, development of an enrichment task force.

Hosey, G.R. (2005). **How does the zoo environment affect the behaviour of captive primates?** *Applied Animal Behaviour Science* 90(2): 107-129. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: welfare, visitors, cage space, comparing primates in captivity and the wild, zoos, nonhuman primates.

Howell, S., J. Fritz, M. Schwandt, and B. Malling (2001). **A community based environmental enrichment program at the Primate Foundation of Arizona.** *American Journal of Primatology* 54(Suppl. 1): 87. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: animal behavior, community involvement, education, donations, Primate Foundation of Arizona, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Khan, U. (2003). **Enrichments and enclosure furnishings for primates**. *Zoos' Print* 18(10): 23-24. ISSN: 0971-6378.
Descriptors: nonhuman primates, care in captivity, environmental enrichment, zoo habitats.

Kravic, M. and K. McDonald (2003). **Environmental enrichment of nonhuman primates with PVC pipe constructs**. *Contemporary Topics in Laboratory Animal Science* 42(4): 120. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: species-specific behavior, perches, swings, arboreal species, height of perches, multiple uses of PVC, installation of enrichment devices, meeting abstract.
Notes: 2003 AALAS National Meeting, Seattle, Washington, USA; October 12-16, 2003.

Lambeth, S.P. and L. Brent (1999). **Environmental enrichment in the new millennium**. *American Journal of Primatology* 49(1): 27. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: roundtable discussion of the USDA proposed interpretive nonhuman primate policy, environmental enhancement programs, program managers, zoo, laboratory, sanctuary, and exhibitor representatives, meeting abstract.
Notes: 22nd Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Lutz, C.K. and M.A. Novak (2005). **Environmental enrichment for nonhuman primates: Theory and application**. *ILAR Journal* 46(2): 178-191. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: Investigators have an obligation to promote the psychological well-being of nonhuman primates used in research. Considerable emphasis has been placed on providing nonhuman primates with enriched environments as a means to achieve this objective. A framework is provided that consists of a set of hypotheses about well-being, and the extent to which exposure to various enrichment devices and procedures actually promotes well-being is evaluated. Two hypotheses are concerned with fostering species-typical behavior: use (versus nonuse) of the

enrichment, and whether use of enrichment helps normalize other aspects of the behavioral repertoire. Two additional hypotheses are concerned with abnormal behavior: whether currently existing enrichment lowers levels of abnormal behavior, and whether it prevents the behavior. This framework is applied to various enrichment strategies ranging from toys and foraging devices to social interaction. Most devices are used by nonhuman primates and thus constitute an important way to enrich the captive environment. However, enrichment devices vary as to their effectiveness in normalizing the behavioral repertoire and eliminating abnormal behavior. Only social contact satisfies the goal of promoting a wide variety of species-typical activities while at the same time reducing or preventing the development of abnormal behavior.
Descriptors: psychological well-being, effectiveness of enrichment devices, promotion of species-typical behavior, science-based approach, reducing or preventing abnormal behavior, importance of social contact, primates as laboratory animals, toys, foraging devices.

Magnussen, F. and V. Melfi. (2004). **Is there a reliable method to rapidly evaluate the success of environmental enrichment in captive primates?** In: *Proceedings of the Sixth Annual Symposium on Zoo Research, July 8-9, 2004, Edinburgh Zoo, Edinburgh, UK,* The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 97-107.
Online: http://www.biaza.org.uk/resources/library/images/ARSP6.pdf
Descriptors: empirically measure impacts of enrichment, nine enrichment devices, sensory, manipulative and nutritional enrichments, focal sampling of behavior, *Colobus polykomos*, king colobus, *Colobus guereza*, Abyssinian colobus, *Hylobates pileatus*, pileated gibbon, *Hylobates muelleri*, grey gibbon, *Ateles paniscus*, Red faced black spider, monkey, zoo settings.

Martin, D.P., T. Gilberto, C. Burns, and H.C. Pautler (2002). **Nonhuman primate cage modifications for environmental enrichment**. *Contemporary Topics in Laboratory Animal Science* 41(5): 47-49. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: Both to meet the regulatory requirements of the Animal Welfare Act and the increasing body of evidence supporting that most species of nonhuman primates (NHP) should be group-housed whenever possible, modifications to nonhuman primate caging are described. Perches and cage-connecting tunnels were fabricated for existing macaque caging. These are semi-permanent, easily sanitizable, and allow for all cage functions to operate as designed. All NHP housed in these cages were part of experimental studies approved by the institutional animal care and use committee.
Descriptors: caging, environmental enrichment, perches, tunnels, IACUC approval, macaques, regulatory requirements.

Mccusker, C. and T.E. Smith (2004). **Odour cues as enrichment tools in primates: Caution**. *Animal Welfare* 13(Suppl.): S248-S249. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: odors, olfactory communication, environmental enrichment, nonhuman primate behavior, auto-grooming, self-directed behaviors, social behavior, animal welfare, meeting abstract.
Notes: Universities Federation for Animal Welfare (UFAW) Symposium on Science in the Service of Animal Welfare, Edinburgh, UK; April 2-4, 2003.

McManamon, R. (1999). **Veterinarian's role in monitoring the behavioral enrichment standards of the Animal Welfare Act**. In: M.E. Fowler and R.E. Miller (Editors), *Zoo and Wild Animal Medicine: Current Therapy,* 4th edition, W.B. Saunders Company: Philadelphia, PA, p. 387-391. ISBN: 0721686648.
NAL Call Number: SF996.Z66 1999
Descriptors: Animal Welfare Act and regulations, nonhuman primate enrichment, exemptions, risk assessment, browse list, developing and documenting an enrichment plan, behavioral goals.

Megna, N. and J. Ganas (2001). **Who's enriching whom? The mutual benefits of involving community seniors in a research facility's enrichment program**. *Laboratory Primate*

Newsletter 40(1): 8-10. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn40-1.html
NAL Call Number: SF407.P7 L3
Descriptors: Alliance for Primate Enrichment by Seniors (APES), environmental enrichment, enrichment treats, behavior, interaction with local seniors.

Morton, W.R. and K. Swindler (2005). **Serendipitous insights involving nonhuman primates.** *ILAR Journal* 46(4): 346-351. ISSN: 1084-2020.
Online: http://dels.nas.edu/ilar%5Fn/ilarjournal/journal.shtml
NAL Call Number: QL55.A1I43
Abstract: Serendipity is discussed as a form of controlled chaos, a phenomenon in a class with synchronicity and other actions affecting research in terms of theory versus observation (e.g., "optional stopping"). Serendipity is a fundamental aspect of basic research, a profitable and normal outcome in the context of "informed observation." The serendipitous finding fits into the following pattern: it is unanticipated, anomalous, and strategic. All observations that have meaning must fit into some context in the observer's mind or suggest a revolutionary new context. It is critically important to maintain access to the resources provided by established primate centers and similar laboratories to capitalize in a timely way on serendipitous findings and to benefit from valuable discoveries made in more directly targeted development investments. Examples are given of serendipitous insights gained in experimentation and observation relative to nonhuman primate research, including both broad and narrow topics. Genomics, which uses comparison-based strategies and capitalizes on the DNA sequences of genetic information, presents what might seem the basis for endless serendipity because nonhuman primates are likely to share most genes present in the human genome. Other topics discussed include infant behavior, birth periodicity, leprosy, cystic fibrosis, environmental enrichment, endocrinology, drug development, and the rapidly expanding study of infectious diseases and pathogen-based bioterrorism.
Descriptors: basic research, resources provided by established primate centers, serendipitous insights, genomics, infant behavior, environmental enrichment, endocrinology, drug development, infectious diseases, valuable information gained from unanticipated findings.

Nelson, R.J. and T.D. Mandrell (2005). **Enrichment and nonhuman primates: "First, do no harm".** *ILAR Journal* 46(2): 171-177. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Descriptors: environmental enrichment, Institutional Animal Care and Use Committees (IACUC), animal care, animal technicians, animal well-being, risk reduction, primates as laboratory animals.

Reinhardt, V. and A. Reinhardt (2000). **The lower row monkey cage: An overlooked variable in biomedical research** . *Journal of Applied Animal Welfare Science* 3(2): 141-149. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: primates as laboratory animals, placement of cages, fearfulness, abnormal behavior, stress, animal experiments, animal welfare, literature reviews.

Reinhardt, V. and A. Reinhardt (2000). **Social enhancement for adult nonhuman primates in research laboratories: A review.** *Lab Animal* 29(1): 34-41. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Descriptors: primates as laboratory animals, enrichment, animal housing, aggressive behavior, males, training of animals, laboratory workers, social housing, pair housing, social enrichment, human-animal interactions.

Reinhardt, V. and A. Reinhardt (2005). ***Annotated Bibliography on Refinement and Environmental Enrichment for Primates Kept in Laboratories***, 8th edition, Animal Welfare Institute: Washington, DC, USA, 89 p.
Online: http://www.awionline.org/lab_animals/biblio/index.html

NAL Call Number: HV4737 .R44 2005
Abstract: This bibliography offers animal caregivers, animal technicians, veterinarians, zoo keepers and students guidance to practical information on refinement and environmental enrichment for primates kept in research institutions.
Descriptors: bibliography on enrichment for nonhuman primates, animal welfare, species-typical behavior, abnormal behavior, social behavior and housing, positive reinforcement training, foraging and food processing behavior, safety concerns, ethics, animal welfare regulations and guidelines, animal use refinement.

Roder, E.L. and P.J.A. Timmermans (2002). **Housing and care of monkeys and apes in laboratories: Adaptations allowing essential species-specific behaviour.** *Laboratory Animals* 36(3): 221-242. ISSN: 0023-6772.
NAL Call Number: QL55.A1L3
Abstract: During the last two decades an increasing amount of attention has been paid to the housing and care of monkeys and apes in laboratories, as has been done with the housing and care of other categories of captive animals. The purpose of this review is to develop recommendations for adaptations of housing and care from our knowledge of the daily behavioural activity of monkeys and apes in natural conditions and in enriched laboratory conditions. This review deals mainly with adaptations of daily housing and care with respect to behaviour, and it is restricted to commonly-used species: Callitrichidae (*Callitrix jacchus*, *Saguinus oedipus*); Cebidae (*Aotus trivirgatus*, *Saimiri sciureus*, *Cebus apella*); Cercopithecidae (*Macaca fascicularis*, *M. mulatta, M. nemestrina, M. arctoides, Chlorocebus aethiops, Papio hamadryas, P. cynocephalus*); Pongidae (*Pan troglodytes*).
Descriptors: *Callithrix jacchus*, *Saguinus oedipus*, *Aotus trivirgatus*, *Saimiri sciureus*, *Cebus apella*, *Macaca fascicularis*, *Macaca mulatta*, *Macaca nemestrina*, *Macaca arctoides*, *Chlorocebus aethiops*, *Papio hamadryas*, *Papio cynocephalus*, *Pan troglodytes*, primates as laboratory animals, New World monkeys, chimpanzees, macaques, abnormal behavior, animal welfare, species differences, group size, cage size, perches, foraging, literature reviews, animal use refinement, environmental enrichment.

Schafer, J. (2004). **Primate popsicles**. *Tech Talk* 10(3): 4.
Online: http://www.aalas.org/pdfUtility.aspx?pdf=TT/10_3.pdf
Descriptors: foraging enrichment, cost effective enrichment, cleanliness of enrichment, frozen enrichment treats, fruits and vegetables.

Schapiro, S.J. (2000). **A few new developments in primate housing and husbandry**. *Scandinavian Journal of Laboratory Animal Science* 27(2): 103-110. ISSN: 0901-3393.
Descriptors: primates as laboratory animals, animal husbandry, animal training, animal welfare.

Schub, T. and M. Eisenstein (2003). **Enrichment devices for nonhuman primates**. *Lab Animal* 32(10): 37-40. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: There has been in recent years a substantial increase in the variety of enhancement devices available for nonhuman primates in captivity, and the task of properly outfitting a housing unit can be daunting. Researchers continue to investigate the specific impact and importance of environmental enrichment, but it is generally accepted that increasing the complexity of the environment for the mental and physical stimulation of nonhuman primates is beneficial to their health and contentment, and enrichment is now a standard component of primate husbandry.
Descriptors: housing environment, laboratory animals, animal welfare legislation, environmental complexity.

Smith, J.A. and K.M. Boyd (2003). **The Boyd Group of Papers on: The use of non-human primates in research and testing.** *Animal Technology and Welfare* 2(2): 99-110. ISSN: 0264-4754.
NAL Call Number: SF757.A62
Descriptors: primates as laboratory animals, *Macaca mulatta*, toxicology, disease diagnosis, animal law, biomedical research, training of animals, neurophysiology, animal models, animal

welfare, animal use alternatives, *Macaca fascicularis*, *Callithrix jacchus*, animal behavior, housing.

Ueno, Y. (2005). **Welfare for primates as research resources**. *Natural History Journal of Chulalongkorn University* (Suppl. 1): 65-70. ISSN: 1513-9700.
Descriptors: nonhuman primates as laboratory animals, ethics, cognitive abilities, physical and psychological well-being, environmental enrichment as a strategy for animal health, performance standards.

Veira, Y. and L. Brent (2000). **Behavioral Intervention Program: Enriching the lives of captive nonhuman primates**. *American Journal of Primatology* 51(Suppl. 1): 97. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: abnormal behavior, psychological distress, environmental enrichment, behavioral treatment options, rearing history, research and breeding programs, meeting abstract.
Notes: 23rd Annual Meeting of The American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Waitt, C., H.M. Buchanan Smith, and K. Morris (2002). **The effects of caretaker-primate relationships on primates in the laboratory**. *Journal of Applied Animal Welfare Science* 4(5): 309-319. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: As contact with caretakers is likely to make up the majority of human-primate interactions in laboratories, caretakers represent an important influence in the lives of captive primates. The aim of this study was to determine how caretaker-primate relationships affected the behavior of primates in the laboratory. We examined whether stump-tailed macaques (*Macaca arctoides*) who were evaluated by caretakers as being either friendly or unfriendly differed in the quality and quantity of interactions with their caretakers during husbandry procedures and in their behavior at times of high and low levels of caretaker activity. Results revealed that animals who had friendly relationships with caretakers were less disturbed by routine husbandry procedures, approached caretakers more often, and were willing to accept food offered by caretakers compared with animals considered unfriendly toward their caretakers. The study concluded that the quality of the primate-caretaker relationship may have an important impact on behavior and may have implications for the well-being of animals and caretakers, as both can benefit from positive feedback from one another.
Descriptors: stump-tailed macaques, *Macaca arctoides*, human-animal relationships, animal behavior, laboratory, husbandry procedures, caretaker activity levels, animal well-being.

Weed, J.L., K.C. Baker, and C.M. Crockett (2003). **Managing behavioral health and environmental enrichment of laboratory primates**. *American Journal of Primatology* 60 (Suppl. 1): 34. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: workshop, behavioral management programs, environmental enrichment programs, social enrichment, positive reinforcement training, well-being, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Alberta, Canada; July 30-August 2, 2003.

Weed, J.L., R. Byrum, S. Parrish, M. Knezevich, D.A. Powell, and P.L.O.N. Wagner (2002).
Vasectomies as part of an environmental enrichment plan for primates. *American Journal of Primatology* 57(Suppl. 1): 41. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: social enrichment, clinical management tool, pair or group housing, self-injurious behavior, behavioral intervention, male nonhuman primates, vasectomy, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Weed, J.L., K.J. McCollom, and F.A. Cisar (2000). **Methods for socializing unfamiliar primates to**

provide environmental enrichment and promote psychological well-being. *American Journal of Primatology* 51(Suppl. 1): 98. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: social housing, pair housing, age effects, stainless steel or acrylic panels, type of caging, partner selection, meeting abstract.
Notes: 23rd Annual Meeting of The American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Winkler, P. (1999). **European Federation for Primatology Workshop 1998 - Diet, foraging behaviour and time budgets in non-human primates: How field studies may help improve the welfare of captive primates**. *Folia Primatologica* 70(1): 62-64. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: animal welfare, nonhuman primate dies, feeding behavior, *Haplorhini* , *Macaca*, design of research protocols, *Saimiri*, time factors.

Wolfle, T.L. (1999). **Psychological well-being of nonhuman primates: A brief history**. *Journal of Applied Animal Welfare Science* 2(4): 297-302. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: primates as laboratory animals, animal housing, environmental enrichment, cage size, animal behavior, Animal Welfare Act, United States of America.

Wormell, D. and M. Brayshaw (2000). **The design and redevelopment of new world primate accommodation at Jersey Zoo: A naturalistic approach**. *Dodo* 36: 9-19. ISSN: 0265-5640.
Descriptors: zoo enclosure design, use of tree trunks, environmental enrichment, ropes, quality of life, reduction in stress levels, staff involvement in design process, Jersey Zoo.

Abnormal Behavior

Agoramoorthy, G. and M.J. Hsu (1999). **Rehabilitation and release of chimpanzees on a natural island. Methods hold promise for other primates as well.** *Journal of Wildlife Rehabilitation* 22(1): 3-7. ISSN: 1071-2232.
NAL Call Number: SF996.45.J69
Descriptors: *Pan troglodytes*, chimpanzees, release and relocation program, feeding behavior, nest building, aggression, abnormal behavior, stereotypic behavior.

Baker, K. (2002). **Rearing and housing history of rhesus macaques (*Macaca mulatta*) displaying self-injurious and noninjurious abnormal behaviors**. *American Journal of Primatology* 57(Suppl. 1): 82. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: rhesus macaque, *Macaca mulatta*, animal behavior, age when first single housed, noninjurious abnormal behavior, rearing background, self-injurious behavior (SIB), meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Baker, K., M. Bloomsmith, C. Griffis, and M. Gierhart (2003). **Self injurious behavior and response to human interaction as enrichment in rhesus macaques**. *American Journal of Primatology* 60 (Suppl. 1): 94-95. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-injurious behavior (SIB), abnormal behavior, vocalizations, human interaction as environmental enrichment, *Macaca mulatta*, rhesus macaques, stress.

Bellanca, R.U. and C.M. Crockett (2002). **Factors predicting increased incidence of abnormal behavior in male pigtailed macaques**. *American Journal of Primatology* 58(2): 57-69. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: To identify factors predicting abnormal behavior in laboratory monkeys, we observed all available singly housed 4- to 11-year-old male pigtailed macaques (*Macaca nemestrina*), the species/age/sex group most likely to be referred to the Washington National Primate Research Center's Psychological Well-Being Program for behavioral assessment. Of the 87 subjects, 29 had been referred to the program whereas 58 had not. Abnormal behavior was unrelated to the subject's housing location (biocontainment vs. other facility) or invasiveness of research. Nursery-reared subjects displayed more abnormal behavior than mother-reared subjects. Across and within rearing categories, the proportion of the first 48 months of life spent singly housed was positively related to the amount of abnormal behavior at maturity. This effect was stronger for subjects separated from the mother for clinical rather than experimental reasons, and least for mother-reared subjects. Locomotor stereotypy, by far the most frequent form of abnormal behavior, was positively related to time in single housing but was unrelated to rearing. These results reinforce the importance of tactile social contact during juvenility for the prevention of abnormal behavior in social primates. They also suggest that self-directed abnormal behaviors and locomotor stereotypies have different etiologies.
Descriptors: *Macaca nemestrina*, aging, housing, animal, maternal deprivation, motor activity, risk factors, self-injurious behavior, social behavior, stereotypic behavior.

Bellanca, R.U. and C.M. Crockett (2001). **Male pigtailed macaques neonatally separated from mothers for clinical reasons show increased abnormal behavior as adults**. *American Journal of Primatology* 54(Suppl. 1): 52-53. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: animal behavior, abnormal behavior as adults, effects of mother rearing, effects of nursery rearing, social contact, meeting abstract, *Macaca nemestrina*, pigtailed macaques.

Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Bellanca, R.U., K.S. Heffernan, J.E. Grabber, and C.M. Crockett (1999). **Behavioral profiles of laboratory monkeys referred to a regional primate research center's psychological well-being program**. *American Journal of Primatology* 49(1): 33. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: abnormal behavior of captive animals, behavioral profiles, self-injurious behavior (SIB), psychological well-being program, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Bloomsmith, M., K. Baker, and M. Novak (2004). **Understanding and managing self-injurious behavior in nonhuman primates**. *American Journal of Primatology* 62(Suppl. 1): 119. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: roundtable discussion, definition of self-injurious behavior (SIB), physiological basis, literature review, treatment options, current research, meeting abstract.
Notes: 27th Annual Meeting of The American Society of Primatologists, Madison, Wisconsin, USA, June 8-11, 2004.

Bloomsmith, M.L., S. Lambeth, and T. Stoinski (2001). **The behavioral effects of meal predictability on chimpanzees**. *American Journal of Primatology* 54(Suppl. 1): 96. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimps, *Pan troglodytes*, feeding schedules, animal behavior, abnormal behavior, housing type, self-directed behavior , timing of animal husbandry events, meeting abstract.
Notes: 24th Annual Meeting of The American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Bollen, K.S. and M.a. Novak (2000). **A survey of abnormal behavior in captive zoo primates**. *American Journal of Primatology* 51(Suppl. 1): 47. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: nonhuman primate behavior, abnormal behavior, effects of captive environments, zoos, meeting abstract.
Notes: 23rd Annual Meeting of the American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Bolton, I. (2004). **The management of behavioral issues in captive nonhuman primates.** *American Journal of Primatology* 62(Suppl. 1): 43. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: behavioral needs, introduction to symposium, species appropriate behaviors, behavioral management, enrichment, meeting abstract.
Notes: 27th Annual Meeting of The American Society of Primatologists, Madison, Wisconsin, USA, June 8-11, 2004.

Bourgeois, S.R. and L. Brent (2005). **Modifying the behaviour of singly caged baboons: Evaluating the effectiveness of four enrichment techniques**. *Animal Welfare* 14(1): 71-81. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: adolescent male olive hybrid baboons, *Papio hamadryas anubis*, abnormal behavior, effectiveness of enrichment techniques to reduce abnormal behavior, positive reinforcement training, food enrichment, manipulable toys and objects, social environment, activity levels, animal welfare implications, social enrichment as a means of behavior modification for captive baboons.

Bourgeois, S. and L. Brent (2003). **The effect of four enrichment conditions on abnormal behavior in**

seven singly caged baboons (*Papio hamadryas anubis*). *American Journal of Primatology* 60(Suppl. 1): 80-81. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Papio hamadryas anubis*, baboons, single housing, comparison study, effects of environmental enrichment, positive reinforcement training, food enrichment, non-food enrichment, social enrichment, self-directed behavior, caging, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Brent, L., D.M. Foley, and T. Koban (2001). **Abnormal behavior in baboons (*Papio hamadryas anubis sp.*) during the postpartum period**. *American Journal of Primatology* 54(Suppl. 1): 88-89. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: postpartum period, adult female baboons, social groups, animal models, stereotypic behavior, self directed behavior, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Brent, L., T. Koban, and S. Ramirez (2002). **Abnormal, abusive, and stress-related behaviors in baboon mothers**. *Biological Psychiatry* 52(11): 1047-1056. ISSN: 0006-3223.
NAL Call Number: RC321.B55
Abstract: BACKGROUND: Psychiatric disturbances during pregnancy and the postpartum period are especially serious, given the negative effects on the mother as well as the child. Understanding the causes of such disturbances has been difficult owing to the complexity of psychological, social, experiential, biological, and genetic factors involved. METHODS: To determine the potential utility of a nonhuman primate model for the study of postpartum disorders, the pathologic and stress-related behavior of 62 female baboons living in social groups was studied during pregnancy and after the birth of an infant. RESULTS: The prevalence of abnormal behavior and self-directed scratching (a measure of stress response) was higher after birth of the infant. Subjects displayed a significantly higher frequency per hour of these behaviors postpartum, which increased over 8 weeks. Abusive behaviors toward the infant were common, occurring in 55% of the subjects. Mothers with low dominance rank, who usually have lower levels of social support, had higher levels of abusive behavior during the postpartum period. CONCLUSIONS: Baboons show variation in measurable behaviors related to stress and abnormal functioning during the pre- and postpartum periods, indicating that a nonhuman primate model may be useful in the study of factors affecting postpartum psychiatric disorders and infant abuse.
Descriptors: self-directed scratching, female baboons, abnormal behavior, social groups, effect of birth on abnormal behaviors, infant abuse, dominance ranking, possible animal models.

Brune, M., U. Brune Cohrs, and W.C. McGrew (2004). **Psychiatric treatment for great apes?** *Science* 306(5704): 2039. ISSN: 1095-9203.
Online: http://www.sciencemag.org/cgi/reprint/306/5704/2039b.pdf | (327 KB)
Descriptors: laboratory animal psychology, abnormal behaviors, therapeutic use of neurotransmitter agents, *Pan troglodytes*, chimps, animal welfare, animal behavior, letter to the editor.

Chase, W.K., L.M. Marinus, M.J. Jorgensen, K.L. Rasmussen, S.J. Suomi, and M.A. Novak (1999). **Heart rate patterns in rhesus monkeys with self-injurious behavior (SIB): Are these monkeys "high reactors?"**. *American Journal of Primatology* 49(1): 42-43. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-biting, heart rate, reactive temperament, self-injurious behavior (SIB), macaques, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Crockett, C.M. (2004). **Abnormal behaviour in laboratory monkeys**. *Folia Primatologica* 75(Suppl. 1): 130-131. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: abnormal behavior, animal welfare, single housing of nonhuman primates, macaques, meeting abstract.
Notes: Spring Meeting of the Primate Society of Great Britain, St Andrews, Scotland; April 10-11, 2003.

Crockett, C.M. and R.U. Bellanca. (2001). **Using behaviour profiles to identify correlates and possible prevention of abnormal behaviour in laboratory monkeys**. In: *The 18th Congress of the International Primatological Society: Primates in the New Millenium. Abstracts and Programme, January 7-12, 2001, Adelaide, South Australia,* IPS: Adelaide, South Australia, p. 448. [CD-Rom]
Descriptors: self-injurious behavior (SIB), stereotypies, activity levels, motor activity, self-direct behavior, macaques, baboons, meeting abstract.

Crockett, C.M. and G.M. Gough (2002). **Onset of aggressive toy biting by a laboratory baboon coincides with cessation of self-injurious behavior**. *American Journal of Primatology* 57(Suppl. 1): 39. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-injurious behavior (SIB), *Papio cynocephalus anubis*, baboons, animals on a bone marrow transplant protocol, biting of toys, re-direction of tension-related aggression, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologist, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Crockett, C.M., G.P. Sackett, C. Sandman, and a. Chicz Demet (2003). **Beta endorphin levels in longtailed and pigtailed macaques vary by species, sex, and abnormal behavior rating: A pilot study**. *American Journal of Primatology* 60(Suppl. 1): 109-110. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Macaca fascicularis*, *Macaca nemestrina*, cynomolgus macaques, pigtailed macaques, rating abnormal behavior, behavioral reinforcement, sex differences, species differences, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Davenport, M.D., S. Strand, S. Tiefenbacher, J.S. Meyer, C. Shannon, S.J. Suomi, and M.A. Novak. (2002). **Steroid hormone levels in differentially reared juvenile rhesus monkeys**. In: *Society for Neuroscience Abstract Viewer and Itinerary Planner: 32nd Annual Meeting of the Society for Neuroscience, November 2-7, 2002, Orlando, Florida, USA,* Society for Neuroscience: Washington, DC, p. Abstract No. 207.6. [Online]
Online: http://sfn.scholarone.com
Descriptors: comparison study of rearing conditions, cortisol levels, juvenile rhesus macaques, *Macaca mulatta*, separation stress, sex differences, aggression, stereotypical behavior, behavioral development.

Dorey, N., J. Rosales Ruiz, R. Smith, and B. Lovelace. (2004). **A functional analysis of self-injurious behavior in an olive baboon (*Papio hamadryas anubis*)**. In: *Animal Behavior Managment Alliance (ABMA) Conference Proceedings 2004, April 4-9, 2004, Baltimore, Maryland, USA,* p. 81. [CD-Rom]
Descriptors: problematic behavior, zoo animal management, reinforcement, self-injurious behavior (SIB), meeting abstract.

Eaton, G.G., J.M. Worlein, S.T. Kelley, S. Vijayaraghavan, D.L. Hess, M.K. Axthelm, and C.L. Bethea (1999). **Self injurious behavior is decreased by cyproterone acetate in adult male rhesus (*Macaca mulatta*)**. *Hormones and Behavior* 35(2): 195-203. ISSN: 0018-506X.

NAL Call Number: QP801.H7H64
Abstract: Self-injurious behavior (SIB) presents a serious problem in laboratory macaques that cannot be socially housed for scientific reasons and among institutionalized children and adults where it is often associated with different forms of brain dysfunction. We have experienced limited success in reducing SIB in macaques by enhancing their environment with enrichment devices. Psychotropic drugs also help, but problems are associated with their use. Because sexual and aggressive behavioral problems in men have been treated with progestational drugs, we tested the efficacy of cyproterone acetate (CA, 5-10 mg/kg/week) on reducing SIB in 8 singly housed, adult male rhesus macaques. The main findings were: (1) SIB and other atypical behaviors were significantly reduced during CA treatment; (2) serum testosterone was significantly reduced during CA treatment; (3) cerebral spinal fluid (CSF) levels of 5HIAA and HVA, metabolites of serotonin and dopamine, respectively, declined significantly during CA treatment; (4) the duration of SIB positively correlated with levels of 5HIAA in CSF; but (5) sperm counts were not reduced during treatment. Thus, CA was a partially effective treatment (3 months) for adult male macaques whose behavioral problems include SIB. In summary, CA reduced SIB, overall aggression, serum testosterone, CSF 5HIAA, and CSF HVA. We hypothesized that the progestin activity of CA represses the hypothalamic gonadal axis and decreases testosterone, which in turn decreases SIB. In addition, we speculate that the decrease in 5HIAA and HVA in CSF may have been caused by progestins decreasing the activity of MAO. Therefore, the reduction of SIB may also be related to an increase in the availability of active monoamines in the CNS.
Descriptors: self-injurious behavior (SIB), environmental enrichment, use of psychotropic drugs, progestational drugs, cyproterone acetate (CA), adult male rhesus macaques, *Macaca mulatta*, aggression, central nervous system, drug effects on behavior, social isolation, yawning, testosterone levels.

Espinosa Aviles, D., G. Elizondo, M. Morales Martinez, F. Rodriguez Herrejon, and P. Varela (2004). **Treatment of acute self-aggressive behaviour in a captive gorilla (*Gorilla gorilla gorilla*)**. *Veterinary Record* 154(13): 401-402. ISSN: 0042-4900.
Descriptors: captive gorillas, aggression, mental disorders, anxiety, self-directed behavior, self-injurious behavior (SIB).

Honess, P., J. Gimpel, S. Wolfensohn, and G. Mason (2005). **Alopecia scoring: The quantitative assessment of hair loss in captive macaques**. *Alternatives to Laboratory Animals* 33(3): 193-206. ISSN: 0261-1929.
NAL Call Number: Z7994.L3A5
Abstract: Many captive animals show forms of pelage loss that are absent in wild or free-living conspecifics, which result from grooming or plucking behaviours directed at themselves or at other individuals. For instance, dorsal hair loss in primates such as rhesus macaques (*Macaca mulatta*) in research facilities, results from excessive hair-pulling or over-grooming by cage-mates. This behaviour appears to be associated with stress, and is controllable to some extent with environmental enrichment. Quantifying alopecia in primates (as in many species) is therefore potentially useful for welfare assessment. A simple system for scoring alopecia was developed and its reliability was tested. Study 1 showed high interobserver reliability between two independent scorers in assessing the state of monkeys coats from photographs. Study 2 showed that there were no significant differences between the scores derived from photographs and from direct observations. Thus, where hair loss due to hair pulling exists in captive primates, this scoring system provides an easy, rapid, and validated quantitative method, for use in assessing the success of attempts to reduce it via improved husbandry. In the future, such scoring systems might also prove useful for quantifying barbering in laboratory rodents.
Descriptors: rhesus macaques, *Macaca mulatta*, grooming or plucking behaviors, primates in captive environments, quantifying hair loss (alopecia), welfare assessment using hair loss measurements, development of alopecia scoring system.

Honess, P.E. and C.M. Marin (2006). **Enrichment and aggression in primates**. *Neuroscience & Biobehavioral Reviews* 30(3): 413-436.
Descriptors: abnormal behavior, self-injurious behavior (SIB), psychological well-being,

literature review, housing of nonhuman primates, effects of housing, feeding, and environmental enrichment, aggression, animal welfare.

Hook, M.A., S.P. Lambeth, J.E. Perlman, R. Stavisky, M.A. Bloomsmith, and S.J. Schapiro (2002). **Inter-group variation in abnormal behavior in chimpanzees (*Pan troglodytes*) and rhesus macaques (*Macaca mulatta*)**. *Applied Animal Behaviour Science* 76(2): 165-176. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: chimpanzees, *Pan troglodytes*, rhesus macaques, *Macaca mulatta*, abnormal behavior, learning, animal behavior, group size, age effects.

Hosey, G. and L. Skyner. (2004). **Self-injurious behaviour in primates: A survey of British and Irish zoos**. In: *Proceedings of the Sixth Annual Symposium on Zoo Research, July 8-9, 2004, Edinburgh Zoo, Edinburgh, UK,* The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 85.
Online: http://www.biaza.org.uk/resources/library/images/ARSP6.pdf
Descriptors: self-injurious behavior (SIB), questionnaire-based survey, low frequency of SIB in zoos, self-biting, hair pulling, effects of age and sex, meeting abstract.

Hugo, C., J. Seier, C. Mdhluli, W. Daniels, B.H. Harvey, D. Du Toit, S. Wolfe Coote, D. Nel, and D.J. Stein (2003). **Fluoxetine decreases stereotypic behavior in primates**. *Progress in Neuro-Psychopharmacology and Biological Psychiatry* 27(4): 639-643. ISSN: 0278-5846.
Abstract: BACKGROUND: Primates reared in captivity may display stereotypic behaviors. These behaviors are arguably reminiscent of human obsessive-compulsive or posttraumatic symptoms, which respond to selective serotonin reuptake inhibitors (SSRIs). Captive primates with marked stereotypic behaviors were entered into a randomized controlled study of the SSRI, fluoxetine. METHODS: A sample of 10 vervet monkeys with behaviors such as marked saluting, somersaulting, weaving, or head tossing was selected. Subjects were randomized to receive fluoxetine 1 mg/kg for 6 weeks (n=5) or no treatment (n=5). A rater blind to the medication status of subjects noted the frequency of the stereotypic behaviors. RESULTS: Repeated-measures analysis of variance (RM-ANOVA) demonstrated a significant GroupxTime difference with significantly fewer stereotypic symptoms in the fluoxetine group by endpoint. At this time, three of the five fluoxetine-treated subjects (but none of the no-treatment subjects) were responders on the Clinical Global Impressions (CGI) change item (CGI < or =2). CONCLUSIONS: Stereotypic behaviors in captive vervets gradually and partially decrease in response to administration of an SSRI, paralleling research on human anxiety symptoms. Further research on animal stereotypies may be useful in providing appropriate veterinary care, and in exploring the underlying neurobiology of certain psychiatric disorders.
Descriptors: stereotypic behavior, serotonin re-uptake inhibitors (SSRIs), fluoxetine, African green monkeys, vervets, *Cercopithecus aethiops*, treatment of psychiatric disorders.

Kaufman, B.M., A.L. Pouliot, S. Tiefenbacher, and M.A. Novak (2002). **Effects of cage size on abnormal behavior in rhesus monkeys**. *American Journal of Primatology* 57(Suppl. 1): 39-40. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: abnormal behavior, rhesus macaques, *Macaca mulatta*, cage size, baboons, hair pulling, cage shaking, individual housing, open pens, self-biting, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Kaufman, B.M., A.L. Pouliot, S. Tiefenbacher, and M.A. Novak (2004). **Short and long-term effects of a substantial change in cage size on individually housed, adult male rhesus monkeys (*Macaca mulatta*)**. *Applied Animal Behaviour Science* 88(3-4): 319-330. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: abnormal behavior, effects of cage size, general activity reduction, rhesus macaques, *Macaca mulatta*, tension related behavior, individual housing.

Kessel, A. and L. Brent (2001). **The rehabilitation of captive baboons**. *Journal of Medical Primatology* 30(2): 71-80. ISSN: 0047-2565.
NAL Call Number: QL737.P9J66
Abstract: Eleven baboons who had been singly housed indoors for an average of 5 years were moved to outdoor social groups in an attempt to provide a more species-typical environment and reduce high levels of abnormal behavior. Nine of the baboons were observed while in single housing and, over a 6-month period, while housed outdoors socially to document long-term changes in behavior. Abnormal behavior decreased significantly from an average of 14% of the observation time in the single cages to 3% in the sixth month of social housing. Cage manipulation and self-directed behaviors also significantly decreased, while social behavior, enrichment-directed behavior, and locomotion increased in social housing. Baboons that had been in long-term indoor single housing were able to reproduce and form stable social groups without injury. This study provides evidence that even behaviorally disturbed nonhuman primates can be successfully rehabilitated to live in social groups.
Descriptors: captive baboons, species-typical behaviors, abnormal behavior, baboons, single housing to outdoor social housing, animal behavior, cage manipulation, behavioral rehabilitation.

Lutz, C., L. Marinus, W. Chase, J. Meyer, and M. Novak (2001). **Self-injurious behavior in male rhesus macaques: Association with aggression and stress**. *American Journal of Primatology* 54(Suppl. 1): 76-77. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: stress, self-injurious behavior (SIB), abnormal behavior, aggression, male macaques, *Macaca mulatta*, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Lutz, C., L. Marinus, W. Chase, J. Meyer, and M. Novak (2003). **Self-injurious behavior in male rhesus macaques does not reflect externally directed aggression**. *Physiology and Behavior* 78(1): 33-39. ISSN: 0031-9384.
NAL Call Number: QP1.P4
Abstract: Self-injurious behaviors (SIB), such as self-biting and self-wounding, have been observed in a small percentage of captive nonhuman primates. Because rhesus monkeys that exhibit SIB also tend to be more aggressive, it was hypothesized that SIB is related to externally directed aggression and is associated with contexts in which physical contact between participants is prevented. The purpose of this study was to test the hypothesized relationship between SIB and outward aggression. Subjects were first presented with videotapes of conspecifics, scenery and a blank screen, and their behavior was recorded. Levels of salivary cortisol, an indicator of stress, were also measured before and after presentation of the videos. Although aggression increased when subjects viewed tapes containing conspecifics, neither cortisol levels nor self-biting behavior varied as a function of tape content. The subjects were then placed in two additional test situations: an empty room and the same room containing an unfamiliar conspecific. Aggression was significantly higher in the stranger condition compared to the empty room condition. The two situations yielded parallel increases in cortisol, suggesting that being alone was just as stressful as being paired with an unfamiliar conspecific. Self-biting rates were also similar in these two conditions. Thus, contrary to our prediction, increases in aggression did not correlate with increases in SIB. These results suggest that under similarly stressful conditions, SIB and externally directed aggression are unrelated.
Descriptors: captive nonhuman primates, social behavior, salivary cortisol levels, indicators of stress, videotapes of conspecifics, relationship between self-injurious behavior (SIB) and aggression, rhesus macaques.

Lutz, C., S. Tiefenbacher, J. Meyer, and M. Novak (2004). **Extinction deficits in male rhesus macaques with a history of self-injurious behavior**. *American Journal of Primatology* 63(2): 41-48. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Self-injurious behavior (SIB) occurs in both human and nonhuman primate

populations. Despite the potential for harm, SIB may persist in part because of an inability to inhibit behavior that results in wounding. A lever-pressing task was used to test the prediction that monkeys with SIB would show greater persistence in lever-pressing on extinction trials than monkeys without the disorder. The subjects were 15 individually-housed adult male rhesus macaques, 10 of which (the SIB group) had a veterinary record of self-inflicted wounding. All of the monkeys were trained to lever-press for food rewards to a criterion of 400 total responses. The test procedures consisted of five daily 30-min sessions divided into six 5-min intervals. On day 1, the subjects received continuous reinforcement. On days 2-4, testing consisted of alternating reinforced/unreinforced 5-min intervals, beginning with reinforcement. Reinforced intervals were cued with a buzzer. On day 5, the subjects received no reinforcement. The number of lever-presses and behavioral responses were recorded during each session. Saliva samples were collected for cortisol measurement before and after test sessions on days 1, 2, and 5. As predicted, monkeys with SIB lever-pressed more than controls during extinction intervals on days 2-4. There was no difference on day 1 or day 5. The frequency of scratching, yawning, and abnormal behavior increased when reinforcement was intermittent (days 2-4) or absent (day 5). Cortisol levels were highest with continuous reinforcement (day 1), and may reflect differential levels of food intake rather than stress. The presence of extinction deficits suggests that SIB may persist in some monkeys because they lack the ability to regulate the intensity of their biting behavior.
Descriptors: self-injurious behavior (SIB), male macaques, lever-press task trials, levels of reinforcement, frequency of abnormal behavior, cortisol, ability to regulate behavior, five day trial.

Lutz, C., A. Well, and M. Novak (2003). **Stereotypic and self-injurious behavior in rhesus macaques: A survey and retrospective analysis of environment and early experience**. *American Journal of Primatology* 60(1): 1-15. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Abnormal behavior in captive rhesus monkeys can range from active whole-body and self-directed stereotypies to self-injurious behavior (SIB). Although abnormal behaviors are common in singly-housed rhesus monkeys, the type and frequency of these behaviors are highly variable across individual animals, and the factors influencing them are equally varied. The purpose of this investigation was to survey abnormal behavior in a large population of rhesus macaques, to characterize the relationship between stereotypies and self-injury, and to identify potential risk factors for these aberrant behaviors. Behavioral assessments of 362 individually housed rhesus monkeys were collected at the New England Regional Primate Research Center (NERPRC) and combined with colony records. Of the 362 animals surveyed, 321 exhibited at least one abnormal behavior (mean: 2.3, range: 1-8). The most common behavior was pacing. Sex differences were apparent, with males showing more abnormal behavior than females. SIB was also associated with stereotypies. Animals with a veterinary record of self-injury exhibited a greater number of self-directed stereotypies than those that did not self-injure. Housing and protocol conditions, such as individual housing at an early age, longer time housed individually, greater number of blood draws, and nursery rearing, were shown to be risk factors for abnormal behavior. Thus, many factors may influence the development and maintenance of abnormal behavior in captive primates. Some of these factors are intrinsic to the individual (e.g., sex effects), whereas others are related to colony management practices, rearing conditions, and research protocols.
Descriptors: abnormal behavior, relationship between stereotypies and self-injury, risk factors, behavioral assessments, captive primates, sex differences, housing conditions, rearing conditions, research protocols, colony management, rhesus macaques.

Lutz, C.K., W.K. Chase, and M.A. Novak (2000). **Abnormal behavior in singly-housed *Macaca mulatta*: prevalence and potential risk factors**. *American Journal of Primatology* 51(Suppl. 1): 71. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: abnormal behavior, risk factors, age effects, gender effects, colony management, rearing condition, housing conditions, rhesus macaques, *Macaca mulatta*, meeting abstract.
Notes: 23rd Annual Meeting of the American Society of Primatologists, Denver, Colorado, USA;

June 21-24, 2000.

Macy, J.D.Jr., T.A. Beattie, S.E. Morganstern, and A.F.T. Arnsten (2000). **Use of guanfacine to control self-injurious behavior in two rhesus macaques (*Macaca mulatta*) and one baboon (*Papio anubis*)**. *Comparative Medicine* 50(4): 419-425. ISSN: 1532-0820.
NAL Call Number: SF77 .C65
Abstract: Background and purpose: Self-injurious behavior (SIB) affects 0.8 to 10% of individually housed non-human primates, and is a substantial threat to their health and well being. The potential for SIB to involve multiple neurotransmitters and the complex variations in response to external stressors complicate case management. Modulation of the adrenergic system by use of guanfacine, an alpha2A-adrenergic receptor agonist, was assessed as a novel therapeutic strategy for SIB. Methods: The efficacy of guanfacine against SIB was evaluated in 11 self-biting episodes among two rhesus macaques (*Macaca mulatta*) and one baboon (*Papio cynocephalus anubis*). Affected animals were given guanfacine IM or PO at 0.5 mg/kg of body weight twice daily (rhesus) or 0.3 mg/kg (baboon) for 5 to 10 days, followed by gradual reduction of the dose to 0.25 mg/kg (rhesus) or 0.15 mg/kg (baboon) once daily over an average of 33 days. Results: The 0.5 mg/kg twice daily regimen of guanfacine halted all self-biting, whereas reducing the dose to 0.25 mg/kg given twice daily or 0.5 mg/kg given once daily resulted in reversion to self-biting in four of the 11 episodes. Recurrence was controlled by returning to twice daily 0.5 mg/kg dosing for one aggressive episode, and resolved in the three milder episodes without dose or frequency being increased. Self-biting after discontinuation of therapy recurred six times over five years in case 1, three times over 1.5 years in case 2, and three times over one year in case 3. Clinical assessment suggested that guanfacine therapy decreased agitation without overt side effects associated with alpha2-agonists, such as profound sedation. Conclusion: The mechanism for. guanfacine inhibition of self-biting is unclear, but could result from strengthening of prefrontal cortex inhibitory functions. Guanfacine therapy provides an effective psychological stabilizing tool that alleviates self-biting, and provides time to assess and address external stressors and triggers.
Descriptors: *Macaca mulatta*, *Papio anubis*, laboratory animals, abnormal behavior, guanfacine, alpha adrenergic receptor agonists, drug therapy, animal welfare, neuroleptics, case reports.

Mallapur, A. and B.C. Choudhury (2003). **Behavioral abnormalities in captive nonhuman primates**. *Journal of Applied Animal Welfare Science* 6(4): 275-284. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: In this study, we dealt with 11 species of nonhuman primates across 10 zoos in India. We recorded behavior as instantaneous scans between 9 a.m. and 5 p.m. In the study, we segregated behaviors for analyses into abnormal, undesirable, active, and resting. The 4 types of abnormal behavior exhibited included floating limb, self-biting, self-clasping, and stereotypic pacing. In the study, we recorded 2 types of undesirable behavior: autoerotic stimulation and begging. Langurs and group-housed macaques did not exhibit undesirable behaviors. A male lion-tailed macaque and a male gibbon exhibited begging behavior. autoerotic stimulation and self-biting occurred rarely. Males exhibited higher levels of undesirable behavior than did females. Animals confiscated from touring zoos, circuses, and animal traders exhibited higher levels of abnormal behaviors than did animals reared in larger, recognized zoos. The stump-tailed macaque was the only species to exhibit floating limb, autoerotic stimulation, self-biting, and self-clasping. Our results show that rearing experience and group composition influence the proportions of abnormal behavior exhibited by nonhuman primates in captivity. The history of early social and environmental deprivation in these species of captive nonhuman primates probably is critical in the development of behavioral pathologies. Establishing this will require further research.
Descriptors: *Semnipithecus entellus*, *Trachypithecus pileatus*, *Trachypithecus geei*, *Trachypithecus johnii*, *Trachypithecus phayrei*, *Macaca silenus*, *Macaca nemestrina*, *Macaca arctoides*, *Macaca assamensis*, *Macaca radiata*, *Hylobates hoolook*, housing, primate psychology, self-injurious behavior (SIB), stereotypic movement disorder, zoo animals, India.

Marinus, L.M., W.K. Chase, K.L. Rasmussen, M.J. Jorgensen, and M.A. Novak (1999). **Reaction of**

rhesus monkeys with self-injurious behavior to heart rate testing: is biting a coping strategy? *American Journal of Primatology* 49(1): 79. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-biting, coping strategy, heart rate, macaques, locomotor activity, tension reduction, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Martin, J. (2002). **Early life experiences: Activity levels and abnormal behaviours in resocialised chimpanzees**. *Animal Welfare* 11(4): 419-436. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: chimpanzees, *Pan troglodytes*, rearing histories, social deprivation, developmental period, activity levels, abnormal behavior, zoos, enriched social environment.

Meyer, J.S., S. Tiefenbacher, C.K. Lutz, and M.A. Novak (2002). **Physiological correlates of self-injurious behavior in socially reared adult male rhesus monkeys**. *Neurotoxicology and Teratology* 24(3): 420. ISSN: 0892-0362.
Descriptors: adult male rhesus macaques, *Macaca mulatta*, animal behavior, physiology, self-injurious behavior, meeting abstract.
Notes: 26th Annual Meeting of the Neurobehavioral Teratology Society in conjunction with the Forty-Second Annual Meeting of the Teratology Society, Scottsdale, Arizona, USA; June 22-27, 2002.

Nash, L.T., J. Fritz, P.A. Alford, and L. Brent (1999). **Variables influencing the origins of diverse abnormal behaviors in a large sample of captive chimpanzees (*Pan troglodytes*)**. *American Journal of Primatology* 48(1): 15-29. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: The developmental origin of abnormal behaviors is generally associated with early rearing environments that lack sufficient physical and sensory stimulation. However, other factors should also be considered. A large sample of captive chimpanzees (128 males and 140 females) was surveyed for the presence or absence of 18 abnormal behaviors. Origin variables included the subject's source (zoo, pet, performer, or laboratory), rearing (mother- or hand-reared), and sex. Animals were assessed while held at the Primate Foundation of Arizona, University of Texas M. D. Anderson Cancer Center, or White Sands Research Center. There was a confound among origin variables; more hand-reared animals than expected were from laboratories. Logistic regression tested the relationship of rearing and source, with sex as a secondary predictor variable, to each of the abnormal behaviors. There was no clear association between any abnormal behavior and source. However, for coprophagy, relative to animals from the laboratory, zoo animals tended to show a higher prevalence, while performers tended to show a lower prevalence (when rearing and sex were controlled). Rocking and self-sucking were significantly more likely in hand-reared animals. Coprophagy and depilation of self were significantly more likely in mother-reared animals. When rearing and source were statistically controlled, the only significant sex difference was a higher prevalence of coprophagy in females and a higher prevalence of rocking in males. In a second, smaller sample of 25 males and 33 females from Southwest Foundation for Biomedical Research, no significant sex association was found for coprophagy, urophagy, rocking, or self-depilation. In this second sample, coprophagy was also significantly more likely in mother-reared than hand-reared subjects. The association of some abnormal behaviors with mother-rearing suggests that some form of social learning may be involved in the origin of some of these behavior patterns. This indicates that some abnormal behaviors may not be always be indicative of reduced psychological well-being in captive chimpanzees.
Descriptors: rearing conditions, abnormal behavior, type of captive setting, coprophagy, rocking, psychological well-being, rearing effects on males and females, chimps, *Pan troglodytes*.

Novak, M.A. (2001). **Primate psychopathology: New insights on etiology and physiology**. *American Journal of Primatology* 54(Suppl. 1): 111. ISSN: 0275-2565.

NAL Call Number: QL737.P9A5
Descriptors: aggression, behavioral disorder, self-injurious behavior (SIB), risk factors, analgesia, arousal, coping strategy, heart rate, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Novak, M.A. (2003). **Self-injurious behavior in rhesus monkeys: New insights into its etiology, physiology, and treatment.** *American Journal of Primatology* 59(1): 3-19. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Self-injurious behavior (SIB) is a significant human health problem frequently associated with profound intellectual disabilities, genetic diseases, and psychiatric conditions. However, it also occurs in subclinical populations and appears to be on the rise in adolescents and young adults. SIB is also seen in a small percentage of nonhuman primates that injure themselves through biting. We have begun to characterize SIB in rhesus monkeys to identify some of the risk factors associated with this disorder, and to determine the parallels with the human condition. In our study population, 14% of individually housed monkeys (the vast majority of which are males) have a veterinary record for self-inflicted wounding. Wounding is rare, but self-directed biting is common. SIB can be elicited during aggressive altercations and may be associated with husbandry events. Some monkeys appear to be more vulnerable to acquiring SIB. This increased vulnerability is associated with certain social experiences in the first 2 years of life and with exposure to a larger number of moderately stressful events as compared to controls. Monkeys with SIB also have a dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, indicated by a blunted cortisol response to mild stressors. Our findings suggest that SIB may be a coping strategy to reduce arousal. Biting appears to rapidly lower an escalating heart rate. The potentially reinforcing effects of SIB may account for the failure of some treatment regimens. These findings are compared to studies of SIB in humans, and concordances are identified.
Descriptors: self-injurious behavior (SIB), nonhuman primates, risk factors, aggression, effects of husbandry procedures, social experiences, coping strategy, lowering heart rate by biting.

Palit, G., A. Kalsotra, R. Kumar, C. Nath, and M.P. Dubey (2001). **Behavioural and anti-psychotic effects of Ca2+ channel blockers in rhesus monkey**. *European Journal of Pharmacology* 412(2): 139-144. ISSN: 0014-2999.
Abstract: The potential utility of Ca2+ channel blockers in the treatment of various psychiatric disorders has been recently suggested. In the present study, the behavioural and anti-psychotic effects of Ca2+ channel blockers were investigated in unrestrained rhesus monkeys (*Macaca mulatta*) living together in a colony. The different behaviours categorised as social, solitary and abnormal were video recorded and analysed. Graded doses of verapamil (5-20 mg/kg, i.m.) and nimodipine (7.5-30 mg/kg, p.o.) produced a mild decrease in social and solitary behaviour without producing any cataleptic posture in the tested monkeys. In order to determine potential antipsychotic effects, Ca2+ channel blockers were studied in the model of amphetamine-induced psychosis. Amphetamine, at the dose of 2 mg/kg, i.m., induced suppression of approach, contact, grooming, and feeding, whilst vigilance (checking), stereotyped behaviour and oral hyperkinesia were increased in the monkeys. Pre-treatment with verapamil (10 and 20 mg/kg, i.m.) significantly suppressed amphetamine-induced hypervigilance, stereotypy, oral hyperkinesia and tachypnoea but was unable to reverse other amphetamine-induced behavioural effects. Nimodipine showed insignificant anti-psychotic effects at both 15 and 30 mg/kg doses. These results suggest that verapamil has a definite antipsychotic effect without any extrapyramidal side effects and thus may be of clinical significance in the treatment of psychosis.
Descriptors: anti-psychotic effects of Ca2+ channel blockers, group housing, rhesus macaques, *Macaca mulatta*, social behavior, abnormal behavior, behavior classification, verapamil, nimodipine.

Raper, J.R., M.A. Bloomsmith, A. Stone, and L. Mayo (2002). **Use of positive reinforcement training to decrease stereotypic behaviors in a pair of orangutans (*Pongo pygmaeus*)**. *American Journal of Primatology* 57(Suppl. 1): 70-71. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5

Descriptors: zoo animal behavior, positive reinforcement training, well-being, reproductive behavior, social behavior, stereotypic behavior, primates in zoos, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Reader, S.M. and K.N. Laland (2001). **Primate innovation: Sex, age and social rank differences**. *International Journal of Primatology* 22(5): 787-805. ISSN: 0164-0291.
NAL Call Number: QL737.P9I54
Descriptors: sex differences, behavioral variation, social hierarchy, abnormal behavior, innovative behavior, effects of age.

Reinhardt, V. (2002). **Artificial weaning of Old World monkeys: Benefits and costs**. *Journal of Applied Animal Welfare Science* 5(2): 151-156. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: *Macaca mulatta*, *Papio* sp., primates as laboratory animals, early weaning, abnormal behavior, stress, reproductive efficiency, animal welfare, literature reviews, animal use refinement and reduction.

Reinhardt, V. (1999). **Pair-housing overcomes self-biting behavior in macaques**. *Laboratory Primate Newsletter* 38(1): 4-5. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn38-1.html
NAL Call Number: SF407.P7 L3
Descriptors: abnormal behavior, self-biting, compatible social housing, effect of prolonged single-housing, reduction in self-injurious behavior (SIB), macaques.

Reinhardt, V. and M. Rossell (2001). **Self-biting in caged macaques: Cause, effect, and treatment**. *Journal of Applied Animal Welfare Science* 4(4): 285-294. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: *Macaca mulatta*, *Macaca fascicularis*, primates as laboratory animals, vices, animal housing, group size, animal welfare, literature reviews, pair housing.

Sanchez, M.M., C.O. Ladd, and P.M. Plotsky (2001). **Early adverse experience as a developmental risk factor for later psychopathology: Evidence from rodent and primate models**. *Development and Psychopathology* 13(3): 419-449. ISSN: 0954-5794.
Abstract: Increasing evidence supports the view that the interaction of perinatal exposure to adversity with individual genetic liabilities may increase an individual's vulnerability to the expression of psycho- and physiopathology throughout life. The early environment appears to program some aspects of neurobiological development and, in turn, behavioral, emotional, cognitive, and physiological development. Several rodent and primate models of early adverse experience have been analyzed in this review, including those that "model" maternal separation or loss, abuse or neglect, and social deprivation. Accumulating evidence shows that these early traumatic experiences are associated with long-term alterations in coping style, emotional and behavioral regulation. neuroendocrine responsiveness to stress, social "fitness,' cognitive function, brain morphology, neurochemistry, and expression levels of central nervous system genes that have been related to anxiety and mood disorders. Studies are underway to identify important aspects of adverse early experience, such as (a) the existence of "sensitive periods" during development associated with alterations in particular output systems. (b) the presence of "windows of opportunity" during which targeted interventions (e.g., nurturant parenting or supportive-enriching environment) may prevent or reverse dysfunction, (c) the identity of gene polymorphisms contributing to the individual's variability in vulnerability, and (d) a means to translate the timing of these developmental "sensitive periods" across species.
Descriptors: hypothalamo-hypophyseal system physiopathology, pituitary-adrenal system, stress psychology, age factors, anxiety, corticosterone metabolism, *Macaca mulatta*, mental disorders, risk factors, rats, animal models.

Skyner, L.J., J.R. Amory, and G. Hosey (2004). **The effect of visitors on the self-injurious behaviour**

of a male pileated gibbon (*Hylobates pileatus*). *Zoologische Garten* 74(1): 38-41. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: zoo animal behavior, self biting, self-injurious behavior (SIB), zoo visitor impact, chewing behavior, male gibbon, *Hylobates pileatus*.

Steinmetz, H.W., W. Kaumanns, I. Dix, M. Heistermann, M. Fox , and F.J. Kaup (2006). **Coat condition, housing condition and measurement of faecal cortisol metabolites - A non-invasive study about alopecia in captive rhesus macaques (*Macaca mulatta*)**. *Jounal of Medical Primatology* 35(1): 3-11. ISSN: 1098-2345.
NAL Call Number: QL737.P9A5
Descriptors: hair loss, rhesus macaques, endogenous factors, alopecia, coat condition assessment, hypothalamic-pituitary-adrenal (HPA) axis activity.

Steinmetz, H.W., W. Kaumanns, I. Dix, K.-A. Neimeier, and F.J. Kaup (2005). **Dermatologic investigation of alopecia in rhesus macaques (*Macaca mulatta*)**. *Journal of Zoo and Wildlife Medicine* 36(2): 229-238. ISSN: 1042-7260.
NAL Call Number: SF601.J6
Descriptors: alopecia, hair loss, rhesus macaques, coat condition scoring, effects of environmental or behavioral disturbances.

Tarou, L.R., M.A. Bloomsmith, and T.L. Maple (2005). **Survey of stereotypic behavior in prosimians**. *American Journal of Primatology* 65(2): 181-196. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Captive animals have been observed to perform a variety of stereotypic behaviors. However, little is known about stereotypic behavior in prosimians. We sent surveys to 96 AZA-accredited institutions to examine stereotypic behavior in these primates. Forty-eight surveys were returned, providing information on 440 individuals of 10 genera. According to the responses, 13.2% of the prosimians surveyed exhibited some form of stereotypic behavior. Pacing was the most common behavior. A logistic regression was used to examine intrinsic characteristics that might influence the performance of stereotypic behavior. The genus of the prosimian was a significant predictor of stereotypic behavior. Individuals of the genus *Varecia* and *Microcebus* were more likely to engage in stereotypic behavior than members of the other genera. Rearing history, age, and sex were not significant predictors of stereotypic behavior. To examine the influence of extrinsic variables on stereotypic behavior, we transformed the data into the percentage of individuals within the enclosure that were reported to exhibit stereotypic behavior, and analyzed them at the enclosure level using a general linear model (GLM) analysis of variance (ANOVA). The only environmental variable that significantly predicted stereotypic behavior was the frequency with which enrichment was provided. Frequent enrichment was provided to those exhibits with a higher percentage of prosimians that engaged in stereotypic behavior. The results of this survey suggest that stereotypic behavior in prosimians may be associated with intrinsic factors (i.e., individual or genus differences) in addition to extrinsic factors related to housing. This knowledge may be helpful in identifying the causes of and effective treatments for stereotypic behavior in prosimians.
Descriptors: abnormal behavior, pacing, stereotypies, *Varecia sp.*, *Microcebus sp.*, intrinsic factors, zoo animals, genus differences, housing and individual effects on stereotypic behavior, captive prosimians.

Tarou, L., M. Jones, and T. Maple (2001). **Seasonal and daily variation in stereotypic behavior in two species of zoo-housed lemur**. *American Journal of Primatology* 54(Suppl. 1): 94. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: zoo animal behavior, repetitive behavior, stereotypic behavior, lemurs, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Taylor, D.K., T. Bass, G.S. Flory, and F.C. Hankenson (2005). **Use of low-dose chlorpromazine in conjunction with environmental enrichment to eliminate self-injurious behavior in a rhesus macaque (*Macaca mulatta*)**. *Comparative Medicine* 55(3): 282-288. ISSN: 1532-0820.
NAL Call Number: SF77 .C65
Abstract: A 7-year-old, captive-bred, female rhesus macaque was placed in a quarantine facility upon arrival at our institution. At release from quarantine, she was observed pawing at and chewing on her left cheek. Physical examination revealed ulcerative lesions on the buccal surface of the left cheek. Initial differential diagnoses included Cercopithecine herpesvirus 1 (B virus)-induced lesions and bacterial infection. Dental abnormalities and cheek pouch foreign body were ruled out during the physical exam. Treatment with 30 mg/kg cefazolin intramuscularly every 12 h was initiated. Twelve days later, the animal presented with a 2 x 2-cm, full-thickness erosion involving the opposite (right) cheek. Treatment with buprenorphine (0.1 mg/kg intramuscularly every 24 h) was initiated. Cultures for B virus were negative, and only nonpathogenic bacteria were isolated from swabs of the lesions. Hematology and serum chemistry profiles were normal. A wedge biopsy of the lesion revealed no definitive etiology. Further observation revealed that the lesions likely resulted from self-injurious behavior (SIB). Treatment with low-dose chlorpromazine (1 mg/kg intramuscularly once daily for 25 days, and then 0.5 mg/kg intramuscularly once daily for 25 days) was initiated. Bodyweight and condition were maintained during therapy, and serial hematology and serum chemistry profiles were normal. The animal was moved into a different room, and a toy "necklace" was created. The SIB was eliminated, and lesions healed within 35 days. Presently, 20 months after presentation, this animal remains in good health.
Descriptors: self-injurious behavior (SIB), abnormal behavior treatment, primates as laboratory animals, environmental enrichment, chlorpromazine, location change, adult female rhesus macaque, *Macaca mulatta*, pawing and chewing at cheek, behavioral treatment program, toy necklace , case study.

Tiefenbacher, S., M.D. Davenport, M.A. Novak, A.L. Pouliot, and J.S. Meyer (2003). **Fenfluramine challenge, self-injurious behavior, and aggression in rhesus monkeys**. *Physiology and Behavior* 80(2-3): 327-331. ISSN: 0031-9384.
NAL Call Number: QP1.P4
Abstract: Self-injurious behavior (SIB) and aggression have been linked to reduced serotonergic (5-HT) functioning in both humans and nonhuman primates. The present study examined serum prolactin and cortisol responses to the 5-HT releasing agent D,L-fenfluramine (FEN) in 24 individually housed rhesus monkeys (*Macaca mulatta*), 15 of which carried a veterinary record of self-wounding (SW). Subjects received two doses of FEN, 4 and 2 mg/kg, separated by an interval of at least 2 months. For control purposes, monkeys were given an intramuscular saline injection 1 week prior to each FEN challenge. The relationship between the hormonal responses to FEN, wounding history, the rates of self-directed biting and aggression were determined for each animal based on 100 five-minute observations conducted over a period of 12 months surrounding the challenge procedures. Prolactin and cortisol responses to FEN were unrelated either to wounding history or to rates of self-directed biting. However, there were significant inverse correlations between levels of aggression and the prolactin response to both doses of FEN. The present findings provide no evidence for reduced 5-HT system function in rhesus monkeys with SIB under the present challenge conditions. However, the results are consistent with a previously reported inverse relationship between serotonergic activity and aggression. Moreover, a dose-dependent response to FEN was observed only for prolactin, suggesting that this variable is more appropriate than cortisol as an endpoint for FEN challenge in monkeys.
Descriptors: self-injurious behavior (SIB), aggression, serotonergic functioning, cortisol and prolactin responses, D,L-fenfluramine (FEN), wounding in rhesus monkeys, single housing.

Tiefenbacher, S., M.D. Davenport, M.A. Novak, A.L. Pouliot, and J.S. Meyer (2002). **Prolactin and cortisol response to fenfluramine challenge in socially reared captive rhesus monkeys (*Macaca mulatta*) with self-injurious behavior**. *American Journal of Primatology* 57(Suppl. 1): 63-64 . ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-injurious behavior (SIB), rhesus monkeys, *Macaca mulatta*, wounding,

aggression, hormonal responses, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Tiefenbacher, S., K.E. Gabry, M.A. Novak, A.L. Pouliot, P.W. Gold, and J.S. Meyer. (2002). **Central levels of CRF and NPY in male rhesus monkeys with self-injurious behavior.** In: *Society for Neuroscience Abstract Viewer and Itinerary Planner: 32nd Annual Meeting of the Society for Neuroscience, November 2-7, 2002, Orlando, Florida, USA,* Society for Neuroscience: Washington, DC, Abstract No. 398.3. [Online]
Online: http://sfn.scholarone.com
Descriptors: anxiety, self-injurious behavior (SIB), rearing conditions, self-directed biting, age at social separation, corticotropin releasing factor, anxiety-related neuropeptides, male rhesus macaques, meeting abstract.

Tiefenbacher, S., M.J. Jorgensen, M.A. Novak, and J.S. Meyer (1999). **Hypothalamic-pituitary-adrenal and hypothalamic-pituitary-gonadal activity in rhesus monkeys with self-injurious behavior**. *American Journal of Primatology* 49(1): 108-109. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: hypothalamic-pituitary-adrenal activity, hypothalamic-pituitary-gonadal activity, self-injurious behavior, rhesus macaques, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Tiefenbacher, S., L.M. Marinus, M.D. Davenport, A.L. Pouliot, B.M. Kaufman, M.A. Fahey, M.A. Novak, and J.S. Meyer (2003). **Evidence for endogenous opioid involvement in the expression of self-injurious behavior in rhesus monkeys**. *American Journal of Primatology* 60(Suppl. 1): 103. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: acupressure, behavioral expression, central opioid activity, self-injurious behavior (SIB), rhesus macaques, stereotypic behavior, self biting, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Tiefenbacher, S., L.M. Marinus, M.A. Novak, and J.S. Meyer. (2003). **Endogenous opioid activity in a nonhuman primate model of self - injurious behavior.** In: *Society for Neuroscience Abstract Viewer and Itinerary Planner: 33rd Annual Meeting of the Society of Neuroscience, November 8-12, 2003, New Orleans, Louisiana, USA,* Society for Neuroscience: Washington, DC, Abstract No. 960.14. [Online]
Online: http://sfn.scholarone.com
Descriptors: self-injurious behavior (SIB), self-directed biting, levels of plasma beta-endorphin-like immunoreactivity (IR), rhesus macaques, stereotypic behavior, wounding history, plasma opioid activity, SIB effect on endogenous opioid peptide release.

Tiefenbacher, S., M.A. Novak, M.J. Jorgensen, and J.S. Meyer (2000). **Physiological correlates of self-injurious behavior in captive, socially-reared rhesus monkeys**. *Psychoneuroendocrinology* 25(8): 799-817. ISSN: 0306-4530.
Descriptors: self-injurious behavior (SIB), rhesus macaques, monoamine metabolites, cerebrospinal fluid (CSF), cortisol, testosterone, adrenocorticotropic hormone (ACTH), individual housing, self-directed biting, stress.

Tiefenbacher, S., M.A. Novak, C.K. Lutz, and J.S. Meyer (2005). **The physiology and neurochemistry of self-injurious behavior: A nonhuman primate model**. *Frontiers in Bioscience: A Journal and Virtual Library* 10(1): 1-11. ISSN: 1093-4715.
Online: http://www.bioscience.org/
Abstract: Self-injurious behavior (SIB) is a serious behavioral condition that afflicts millions of individuals in the United States alone. The underlying factors contributing to the development of

self-injury in people are poorly understood, and existing treatment strategies for this condition are limited. A low but persistent percentage of socially reared individually housed rhesus monkeys also spontaneously develop SIB. Data obtained from colony records suggest that the risk of developing SIB in socially reared rhesus monkeys is heightened by adverse early experience and subsequent stress exposure. The present review summarizes the physiological and neurochemical findings obtained in this nonhuman primate model of SIB, focusing on monoamine neurotransmitters, neuropeptides, and neuroendocrine systems. The results indicate that monkeys with SIB exhibit long-lasting disturbances in central and peripheral opioid and stress response systems, which lead to increased levels of anxiety. Based on these findings, we propose an integrated developmental-neurochemical hypothesis in which SIB arises from adverse life events in a subset of vulnerable monkeys, is maintained by a persisting dysregulation of several neurochemical and physiological systems, and functions to periodically reduce anxiety when the levels of anxiety become excessive. Implications of this hypothesis for understanding self-injury in patients with borderline personality disorder and members of the general population are discussed.
Descriptors: self-injurious behavior (SIB), treatment strategies, rhesus macaques, early experience, stress exposure, literature review, anxiety, implications for human patients, animal models.

Tiefenbacher, S., M.A. Novak, L.M. Marinus, W.K. Chase, J.A. Miller, and J.S. Meyer (2004). **Altered hypothalamic-pituitary-adrenocortical function in rhesus monkeys (*Macaca mulatta*) with self-injurious behavior**. *Psychoneuroendocrinology* 29(4): 501-515. ISSN: 0306-4530.
Abstract: Individually housed rhesus monkeys sometimes spontaneously develop self-injurious behavior (SIB) in the form of self-directed biting that, on occasion, results in severe tissue damage and mutilation. We previously demonstrated lower levels of plasma cortisol in rhesus monkeys with a history of self-wounding (SW) when compared to non-wounders (NW). Furthermore, cortisol levels were negatively correlated with rates of self-directed biting. The present study was designed to further characterize the relationships between hypothalamic-pituitary-adrenocortical (HPA) activity, self-wounding, and self-directed biting. Basal 24-h urinary free cortisol excretion, the urinary free cortisol response to a low dose of dexamethasone, and the plasma cortisol response to ACTH were examined in 24 individually housed rhesus monkeys, based on wounding history, i.e. the presence/absence of a veterinary record of self-wounding, and current rates of self-directed biting, i.e. the median split of self-directed biting frequency (independent of wounding status). There were no reliable group differences on any of the physiological measures when analyzed by wounding history. However, the plasma cortisol response 30 min post-ACTH stimulation was significantly correlated with wounding recency, such that lower responsivity was associated with more recent wounding episodes. When the results were analyzed on the basis of biting frequency, high frequency biters (HFB) compared to low frequency biters (LFB) showed decreased HPA negative feedback sensitivity to dexamethasone and a trend towards an attenuated plasma cortisol response to ACTH stimulation. These findings suggest that SIB in socially reared monkeys is associated with complex changes in HPA axis function that are related to the expression of the pathology, i.e. self-directed biting, and to the recency of a wounding episode. It remains to be determined whether humans who exhibit SIB show similar alterations in HPA function.
Descriptors: self-directed biting, cortisol levels, self-injurious behavior (SIB), hypothalamic-pituitary-adrenocortical axis function, biting frequency, socially reared animals, rhesus monkeys, single housing.

Tiefenbacher, S., M. Novak, L. Marinus, A. Pouliot, M. Fahey, and J. Meyer (2001). **Cortisol response to ACTH challenge in rhesus monkeys with self-injurious behavior**. *American Journal of Primatology* 54(Suppl. 1): 61-62. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: captive animal behavior, rhesus monkeys, self-injurious behavior (SIB), biting frequency, stress, adrenocorticotropic hormone (ACTH), meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Waitt, C. and H.M. Buchanan Smith (2002). **What time is feeding? How delays and anticipation of feeding schedules affect stump-tailed macaque behavior**. *Applied Animal Behaviour Science* 75(1): 75-85. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: husbandry routine, psychological well-being, *Macaca arctoides*, stump-tailed macaques, timing of food delivery, captive animal behavior, self-directed behavior, predictability of feeding.

Weed, J.L., R. Byrum, S. Parrish, M. Knezevich, D.A. Powell, and P.L.O.N. Wagner (2002).
Vasectomies as part of an environmental enrichment plan for primates. *American Journal of Primatology* 57(Suppl. 1): 41. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: social enrichment, clinical management tool, pair or group housing, self-injurious behavior, behavioral intervention, male nonhuman primates, vasectomy, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Weed, J.L., P.O. Wagner, R. Byrum, S. Parrish, M. Knezevich, and D.A. Powell (2003). **Treatment of persistent self-injurious behavior in rhesus monkeys through socialization: A preliminary report**. *Contemporary Topics in Laboratory Animal Science* 42(5): 21-23. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: This paper is a retrospective report describing outcomes for six male rhesus monkeys, each with a history of persistent self-injurious behavior (SIB), after their social introduction to female rhesus monkeys. Pairing procedures for five of the six male primates were implemented after surgical vasectomy. One male had previous pairing experience with a female prior to vasectomy resulting in an unplanned pregnancy. This male was re-socialized with his former female partner after surgery. The SIB-related medical histories of the males before and after the pairings are presented. One goal for promoting pair-housing of chronic SIB male monkeys with female monkeys was to determine whether this intervention would function to reduce or eliminate the expression of SIB and thus provide enhanced socialization opportunities for previously singly housed animals.
Descriptors: *Macaca mulatta*, male rhesus macaques, self-injurious behavior, socialization with females, vasectomy, pair housing conditions, retrospective studies.

Wells, D.L. and E.C. Blaney. (2003). **Camouflaging gorillas: A method of reducing the 'visitor effect'**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 332-333.
Descriptors: gorillas, *Gorilla gorilla*, zoo housing and exhibiting techniques, aggressive behavior, abnormal behavior, stereotypic behavior, camouflage net barrier, visitor effects on behavior.

Yokoyama, C., H. Onoe, K. Onoe, H. Tsukada, Y. Watanabe, and K. Fukui (2003). **[Non-human primate behaviors as models for development of higher cognitive functions]**. *Nihon Shinkei Seishin Yakurigaku Zasshi* 23(1): 1-9. ISSN: 1340-2544.
Abstract: Non-human primate behaviors have a special value for the neurobiological study of the development of higher cognitive functions of humans, because of the near evolutional relation between two species. We surveyed results and futures of neurobiological studies of a retrieval task, a learning-set and a self-injurious behavior expressed by non-human primates. On the retrieval task that is related to the development of inhibitory control, it was revealed a hierarchical ordering of inhibitory control processes in which the distinct neuronal circuits were involved. On the learning-set that is related to the development of abstract thinking, neural circuits for the individual learning dramatically changed from an automatic process to a cognitive process depending on the learning-set formation. The self-injurious behavior is expressed during early normal development in humans, and no other animals but non-human primates express it without administration of drugs. For that behavior, probable change in interactions of multiple monoaminergic systems was suggested as its underlying causes. Further studies on

development of higher cognitive functions using non-human primates could be required for understanding the nature of human cognition.
Descriptors: neurobiological studies, retrieval task, learning set, self-injurious behavior, nonhuman primates, monoaminergic system, cognition.
Language of Text: Japanese.

Great Apes and Gibbons

Abello, M., M. Velasco, and F. Esteban (1999). **A training programme for a male gorilla at the Barcelona Zoo**. *International Zoo News* 46(7): 418-420. ISSN: 0020-9155.
NAL Call Number: QL76.I58
Descriptors: semen collection, gorillas in zoos, *Gorilla gorilla*, Barcelona Zoo, Spain, animal training program.

Allard, S.M., T.S. Stoinski, M.A. Bloomsmith, and T.L. Maple (2003). **The effects of enrichment structures on captive gorilla behavior**. *American Journal of Primatology* 60 (Suppl. 1): 95-96. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: gorillas, foraging behavior, captive animals in zoos, environmental enrichment, animal behavior, affiliative behavior, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003. Guest Editor: Marilyn A. Norconk.

Baker, K.C. (2004). **Benefits of positive human interaction for socially housed chimpanzees**. *Animal Welfare* 13(2): 239-245. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: human interaction as environmental enrichment, positive interactions, social interactions, animal behavior, adult chimps, grooming, reduction in levels of abnormal behaviors.

Baker, K.C. (2000). **Advanced age influences chimpanzee behavior in small social groups**. *Zoo Biology* 19(2): 111-119. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: animal behavior, social interactions, age influences on social behavior, captive management of chimpanzees, enrichment devices, social housing, aggression, object manipulation.

Baker, K.C. and F. Aureli (2000). **Coping with conflict during initial encounters in chimpanzees**. *Ethology* 106(6): 527-541. ISSN: 0179-1613.
NAL Call Number: QL750.E74
Descriptors: *Pan troglodytes*, social behavior, agonistic behavior during animal introductions, allogrooming, chimpanzees, cost and benefits of social grouping.

Baker, K., M.L. Bloomsmith, S. Ross, S. Lambeth, and P. Noble (2001). **Control vs. passive exposure to joystick controlled computer tasks intended as enrichment for chimpanees (*Pan troglodytes*)**. *American Journal of Primatology* 54(Suppl. 1): 64. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: behavioral enrichment, joystick tasks, vocalizations, animal welfare, food rewards, chimps, control of environment, meeting abstract.
Notes: 24th Annual Meeting of The American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Baker, K.C., E. Seres, F. Aureli, and F.B. De Waal (2000). **Injury risks among chimpanzees in three housing conditions**. *American Journal of Primatology* 51(3): 161-175. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Meeting the psychological needs of chimpanzees (*Pan troglodytes*) can be a challenge given their aggressiveness on the one hand and the complexity of their social lives on the other. It is unclear how to balance the need to provide opportunities for species-appropriate behavior against potential risks of injury chimpanzees may inflict on each other. This study evaluates the suggestion that simpler social environments protect chimpanzees from wounding.

Over a two-year period all visible injuries to 46 adult males, 64 adult females, and 25 immature chimpanzees were recorded at the Yerkes Regional Primate Research Center. Approximately half of the subjects were mother-reared, and the rest were nursery-reared. Housing included compounds containing about 20 chimpanzees, interconnected indoor-outdoor runs for groups of up to 12 individuals, and smaller indoor-outdoor runs for pairs and trios. Annual wounding rates were calculated for serious wounds (extensive injuries and all those requiring veterinary intervention) as well as for minor wounds. Compound-housed chimpanzees incurred the highest level of minor wounding, but serious wounding levels were not affected by housing condition. Even with a period of dominance instability and elevated levels of wounding in one compound, compound chimpanzees were not injured more than those in smaller social groups over the long term. Nursery-reared females in moderate-sized groups were wounded more than mother-reared females. Also, nursery-reared males and females were wounded less often when paired with mother-reared companions. Overall, this study indicates that maintaining chimpanzees in pairs and trios would not be an effective means for reducing injuries. The management of wounding in chimpanzee colonies is influenced more by the sex and rearing composition of a colony.
Descriptors: animal welfare, three housing situations, comparison study, *Pan troglodytes*, wounds and injuries, aggression, risk assessment, Yerkes Primate Research Center.

Bell, B. and P. Khan. (2001). **Training multi-task medical behaviors in the bonobo (*Pan paniscus*).** In: *The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo,* Chicago Zoological Society: Brookfield, Illinois, USA, p. 128-130. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACBell.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: training for medical behavior, bonobos, *Pan paniscus*, ultrasound measurements, squeeze restraint, routine blood draws, Milwaukee County Zoo, USA.

Birke, L. (2002). **Effects of browse, human visitors and noise on the behaviour of captive orangutans**. *Animal Welfare* 11(2): 189-202. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Pongo pygmaeus*, herbaceous browse, zoo animal behavior, enrichment, human activity, zoo animals, visitor behavior, visitor impact, animal welfare, human-animal interactions, environmental enrichment.

Bloomsmith, M.A., K.C. Baker, S.P. Lambeth, S.K. Ross, and S.J. Shapiro. (2001). **Is giving chimpanzees control over environmental enrichment a good idea?** In: *The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo, Brookfield, IL,* Chicago Zoological Society: Chicago, Illinois, USA, p. 88-89. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACBloom2.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: psychological well-being, providing animals control over their environment, chimps, *Pan troglodytes*, computer-joystick task, behavioral change.

Bloomsmith, M.A., K.C. Baker, S.K. Ross, and S.P. Lambeth (1999). **Comparing animal training to non-training human interaction as environmental enrichment for chimpanzees**. *American Journal of Primatology* 49(1): 35-36. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimpanzees, *Pan troglodytes*, animal care, animal training, environmental enrichment, non-training human interactions, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Bloomsmith, M., K.C. Baker, S.R. Ross, and K.A. Pazol (2002). **The behavioral effects of early rearing experience on captive chimpanzee behavioral development: The juvenile years**. *American Journal of Primatology* 57(Supplement 1): 54-55. ISSN: 0275-2565.
Descriptors: chimpanzees, *Pan troglodytes*, social behavior and development, abnormal behavior, early rearing experience, play behavior, meeting abstract.

Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 01-04, 2002.

Bloomsmith, M., L. Brent, and K. Baker (2001). **The care and management of captive chimpanzees workshop: Managing social behavior**. *American Journal of Primatology* 54(Suppl. 1): 25. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: positive reinforcement training, environmental enrichment, animal husbandry, social behavior, *Pan troglodytes*, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Bloomsmith, M.A. and J.G. Else (2005). **Behavioral management of chimpanzees in biomedical research facilities: The state of the science**. *ILAR Journal* 46(2): 192-201. ISSN: 1084-2020.
NAL Call Number: QL55.A1I43
Abstract: The current status of the behavioral management of chimpanzees housed in US research facilities is examined, and recent advances are described. Behavioral management includes the application of environmental enrichment, animal training, and environmental design for improving animal welfare. Authors surveyed the six major chimpanzee holding facilities and found that the vast majority of chimpanzees are housed socially, with access to the outdoors. The institutions currently invest in behavioral scientists, enrichment specialists, and, most recently, chimpanzee trainers to implement and study chimpanzee behavioral management. This review is based on the substantial scientific literature related to managing social behavior, identifying the behavioral effects of restricted socialization, evaluating various forms of enrichment, and describing positive reinforcement animal training. Authors outline recent accomplishments in behavioral management, summarize behavioral issues that have been evaluated, and identify issues for future consideration. It is proposed that the enhanced application of behavioral management techniques, including training, could significantly reduce chimpanzee stress that is generally associated with experimental manipulations, and could improve animal welfare and the quality of biomedical research. The next challenge is to implement effectively and thoroughly the approaches that have been shown to be beneficial.
Descriptors: environmental enrichment, animal training, environmental design, animal welfare, behavioral management of chimpanzees in biomedical research, United States of America, results of a survey, literature review, managing social behavior, positive reinforcement training, chimps, *Pan troglodytes*.

Bloomsmith, M.A. and S.P. Lambeth (2000). **Videotapes as enrichment for captive chimpanzees (*Pan troglodytes*)**. *Zoo Biology* 19(6): 541-551. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: male and female chimpanzees, group size, responses to video recordings, animal behavior, enrichment , effects of housing, sex differences, visual stimuli, environmental enrichment.

Bloomsmith, M.A., S.P. Lambeth, J.E. Perlman, M.A. Hook, and S.J. Schapiro (2000). **Control over videotape enrichment for socially housed chimpanzees**. *American Journal of Primatology* 51(Suppl. 1): 44-45. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: videotapes as enrichment for chimps, social behavior, social housing, visual stimuli, meeting abstract.
Notes: 23rd Annual Meeting of the American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Bloomsmith, M.L., S. Lambeth, and T. Stoinski (2001). **The behavioral effects of meal predictability on chimpanzees**. *American Journal of Primatology* 54(Suppl. 1): 96. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimps, *Pan troglodytes*, feeding schedules, animal behavior, abnormal behavior,

housing type, self-directed behavior, timing of animal husbandry events, meeting abstract.
Notes: 24th Annual Meeting of The American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Bloomsmith, M.A., S.K. Ross, and K.C. Baker (2000). **Control over computer-assisted enrichment for socially housed chimpanzees**. *American Journal of Primatology* 51(Suppl. 1): 45. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: animal care, chimps, scan sampling technique, behavioral observation, computer-assisted enrichment, social housing, meeting abstract.

Brent, L. (2004). **Solutions for research chimpanzees**. *Lab Animal* 33(1): 37-43. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: As one of humankind's closest animal relatives, the chimpanzee has proven to be a valuable but controversial research model. The author provides an overview of efforts to improve chimpanzee welfare, and describes a facility dedicated to providing lifelong care for these nonhuman primates following retirement from research.
Descriptors: ethics of animal experimentation, animal welfare, research models, *Pan troglodytes*, animal husbandry, legislation.

Brent, L. (2001). **Behavior and environmental enrichment of individually housed chimpanzees**. In: *Special Topics in Primatology,* Vol. 2, American Society of Primatologists: Chicago, Illinois, USA, p. 146-171. ISBN: 096583011X.
NAL Call Number: QL737.P96 C355 2001
Descriptors: *Pan troglodytes*, chimps, enrichment, individually housed animals, impacts of enrichment on behavior, review article.

Buckley, C. (2003). **Captive orang-utans (*Pongo pygmaeus*) and environmental enrichment**. *Ratel* 30(1): 11-22. ISSN: 0305-1218.
NAL Call Number: QL77.5.R37
Descriptors: *Pongo pygmaeus*, zoos, enriched environment, care in captivity, Dublin Zoo, Ireland.

Burks, K. (2001). **Bachelor gorilla introductions: using empirical data in decision-making**. In: *The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo, Brookfield, IL,* Chicago Zoological Society: Chicago, Illinois, USA, p. 67-70. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACBurks.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: social groups , Western lowland gorillas, *Gorilla gorilla gorilla*, animal introductions, formation of bachelor groups, decision making, animal behavior, empirical data, Disney's Animal Kingdom, Orlando, Florida, USA.

Burks, K.D., M.A. Bloomsmith, D.L. Forthman, and T.L. Maple (2001). **Managing the socialization of an adult male gorilla (*Gorilla gorilla gorilla*) with a history of social deprivation**. *Zoo Biology* 20(5): 347-358. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: adult male gorilla, zoo animals, socially deprived individual, aggressive behavior, behavior change, group size, attachment behavior, agonistic behavior, social behavior, animal welfare.

Casler, L.E. and L.T. Nash (1999). **Day nest building and nest use by captive chimpanzees (*Pan troglodytes*)**. *American Journal of Primatology* 49(1): 41-42. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimps, behavioral enrichment, nest building and usage, substrate used to build nests, rearing differences, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana,

USA; August 12-16, 1999.

Celli, M.L., M. Tomonaga, T. Udono, M. Teramoto, and K. Nagano (2003). **Tool use task as environmental enrichment for captive chimpanzees.** *Applied Animal Behaviour Science* 81(2): 171-182 . ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: *Pan troglodytes*, environmental enrichment, animal welfare, foraging, using tools to access honey, animal behavior, physical activity, learning, animal well-being.

Condon, E. and S. Wehnelt. (2003). **The effect of an enriched environment on behavioural and hormonal indicators of welfare in orang-utans at Chester Zoo.** In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, England, p. 53-58.
Descriptors: *Pongo pygmaeus*, stress hormones, cortisol levels, animal behavior, impacts of environmental enrichment, animal welfare, Chester Zoo, UK.

Cox, C.R., T.T. Dubois, and V.I. Renzetti (2002). **Effects of supplemental feeding enrichment on gorilla (*Gorilla gorilla gorilla*) activity at the Los Angeles Zoo.** *American Journal of Primatology* 57(Suppl. 1): 83. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: gorillas, animal behavior, food seeking opportunities, foraging behavior, leafy browse, regurgitation and reingestion, safflower seeds, Los Angeles Zoo, California, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Craig, J. (2004). **Training an older orangutan (*Pongo pygmaeus abelii*) for voluntary injection.** In: *Animal Behavior Management Alliance (ABMA) Conference Proceedings 2004, April 4-9, 2004, Baltimore, Maryland, USA,* Animal Behavior Management Alliance: p. 68. [CD-Rom]
Descriptors: chemical immobilization, shaping behavior, presentation of body parts, zoos.

Cranfield, M. (2004). **Risk/benefit of behavior modification of the mountain gorilla (*Gorilla beringei beringei*): A conservation tool or detriment?** In: *Animal Behavior Management Alliance (ABMA) Conference Proceedings 2004, April 4-9, 2004, Baltimore, Maryland, USA,* Animal Behavior Management Alliance: p. 85. [CD-Rom]
Descriptors: habituation to humans, behavioral data collection, stress, compromising animal health, enabling veterinary care, meeting abstract.

Enciso, A.E., J.M. Calcagno, and K.C. Gold (1999). **Social interactions between captive adult male and infant lowland gorillas: Implications regarding kin selection and zoo management.** *Zoo Biology* 18(1): 53-62. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: male gorilla, captive animals, parental behavior, male animals, aggressive behavior, kin selection, young animals, adult male-infant interactions.

Franklin, J.A. and S.R. Taylor. (2000). **The health management of orangutans through training.** In: *American Zoo and Aquarium Association Regional Conference Proceedings,* American Zoo and Aquarium Association: Wheeling, West Virginia, USA, p. 1-2. ISBN: ISSN: 1088-0402.
NAL Call Number: QL76.5.U6A47
Descriptors: *Pongo pygmaeus*, care in captivity, health management through training.

Fritz, J. (2004). **Do chimpanzees like music? Will they choose their own?** *Laboratory Primate Newsletter* 43(4): 6. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn43-4.html#music
Descriptors: environmental choice, Primate Foundation of Arizona, choice of music, brief introduction to a chimp study.

Grisham, J., F. Lyon, P. Pearson, and C. MacFarlane (2000). **Great EscApe: The great ape facility at Oklahoma City Zoological Park**. *International Zoo Yearbook* 37: 366-374. ISSN: 0074-9664.
NAL Call Number: QL76.I5
Descriptors: exhibit design and construction, great apes, biology and conservation, educational experience, landscaping, natural surroundings, Oklahoma City Zoo, Oklahoma, USA.

Grundmann, E. and M.C. Bomsel (2000). **Nests and nest building behaviour in rehabilitant orangutans (*Pongo pygmaeus*)**. *Folia Primatologica* 71(4): 227. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: behavior, focal sampling of behavior, videotaping, nest architecture, nesting behavior, reintroduction programs, social learning , socialization cages, meeting abstract.
Notes: 6th Congress of the German Primate Society, Utrecht, Germany; August 18-21, 1999.

Guillen-Salazar, F., E. Font, and A. Sendra (2001). **The presence of visitors does not affect the results of an instrumental enrichment programme for chimpanzees (*Pan troglodytes*)**. *Folia Primatologica* 72(6): 357. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: chimps, *Pan troglodytes*, visitor effects on chimp behavior, environmental enrichment program, animal welfare, primates in captivity, housing, pipe feeder, Valencia Zoo, Spain, meeting abstract.
Notes: 1st Meeting of the Asociacion Primatologica Espanola (APE) and the First European Workshop on Primate Research, Madrid, Spain; October 16-19, 1996.

Guillen-Salazar, F., E. Font, A. Sendra, and I. Docavo (2001). **Evaluacion de dos procedimientos de enriquecimiento ambiental para chimpances (*Pan troglodytes* Blumenbach, 1799) en el Zoologico de Valencia (Espana). [Evaluation of two environmental enrichment devices for chimpanzees (*Pan troglodytes* Blumenbach, 1799) at the Valencia Zoo (Spain)]**. *Boletin De La Real Sociedad Espanola De Historia Natural Seccion Biologica* 96(3-4): 263-271. ISSN: 0366-3272.
NAL Call Number: 442.9 SO18
Descriptors: *Pan troglodytes*, chimps, Valencia Zoo, Spain, environmental enrichment devices, primates in captivity, pipe feeder, enrichment evaluation, activity patterns of captive animals, animal behavior.
Language of Text: Spanish; Summary in English and Spanish.

Guillen-Salazar, F., C. Perez-Selles, and S. Navarro-Serra (2005). **Evaluation of an environmental enrichment technique for chimpanzees (*Pan troglodytes*) by means of a single case experimental design**. *Folia Primatologica* 76(1): 54. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: animal welfare, environmental enrichment techniques, relatively small sample size of zoo animal populations, new experimental design, adult male chimpanzee, Valencia Zoo, Spain, effect of enrichment on animal's activity budget, meeting abstract .
Notes: 5th Meeting of the Spanish Primatological Society, Valencia, Spain; September 16 -20, 2003.

Harper, P. (2001). **Eight years of environmental enrichment for Adelaide Zoo's adult male orangutan**. *Australasian Primatology* 15(1): 15-23.
Descriptors: *Pongo pygmaeus*, adult male orangutan, environmental enrichment, zoo enclosures, animal welfare, Adelaide Zoo, Australia.

Harvey, H., T. Rice, R. Kayhart, and C. Torres (2000). **The effects of specific types of music on the activity levels of singly housed chimpanzees (*Pan troglodytes*)**. *American Journal of Primatology* 51(Suppl. 1): 60. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimp behavior, *Pan troglodytes*, chimpanzees, individual housing, musical and auditory enrichment, type of music, meeting abstract.

Notes: 23rd Annual Meeting of the American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Hebert, P.L. and K. Bard (2000). **Orangutan use of vertical space in an innovative habitat**. *Zoo Biology* 19(4): 239-251. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: importance of vertical space, exhibit design, instantaneous scan sampling, activity levels, species-typical behavior, *Pongo pygmaeus*, orangutans, use of space, stereotypical behavior, use of lower canopy and skylights.

Hill, S.P. and D.M. Broom. (2003). **Home improvements: Behavioural responses of captive gorillas (*Gorilla gorilla gorilla*) to enrichment efforts**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, England, p. 1-3.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: adult gorillas, *Gorilla gorilla gorilla*, environmental manipulation, encouraging normal behavior, food presentation, husbandry routines, coping responses, European zoos, Duisburg Zoo (Germany), Paignton Zoo (UK), Lisbon Zoo (Portugal).

Hirata, S. and N. Morimura (2000). **Naive chimpanzees' (*Pan troglodytes*) observation of experienced conspecifics in a tool-using task**. *Journal of Comparative Psychology* 114(3): 291-296. ISSN: 0735-7036.
Abstract: The authors investigated the occurrence of naive chimpanzees' (*Pan troglodytes*) spontaneous observation of experienced conspecifics during a tool-use task entailing honey fishing. The chimpanzees were presented with 20 kinds of "tools" of which 12 kinds were usable. Six pairs of naive and experienced chimpanzees were brought to this honey-fishing situation. A total of 40 observation episodes occurred between the naive and experienced groups, 34 of which were from naive toward experienced individuals. Naive chimpanzees never observed their partners after their own success but did so after their own failure or before their first attempts. In addition, there were 10 cases in which naive individuals used the left-over tools of the experienced ones. Two factors for the transmission of tool use were clearly evident in this study: (a) spontaneous observation of an appropriate behavioral sequence and (b) enhanced environmental cues made by skilled individuals.
Descriptors: imitative behavior, *Pan troglodytes*, chimpanzee use of tools, problem solving, cognition and learning, social behavior, honey fishing.

Hoffman, K., S. Howell, M. Schwandt, and J. Fritz (2002). **Vasectomy as a birth control modality for captive chimpanzees**. *Lab Animal* 31(8): 45-48. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Descriptors: animal husbandry, animal welfare, contraception, *Pan troglodytes*, male chimpanzees, vasectomy, animal behavior, contraception methods, guidelines.

Howell, S. and J. Fritz (1999). **The nuts and bolts of captive chimpanzee diets and food as enrichment: a survey**. *Journal of Applied Animal Welfare Science* 2(3): 205-215. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: chimpanzees, *Pan troglodytes*, animal feeding, foods for enrichment, animal welfare, diets, leafy browse, breakfast cereals, surveys.

Howell, S., J. Fritz, M. Schwandt, B. Malling, and K. Miles (2001). **A community based occupational enrichment program for captive chimpanzees**. *Lab Animal* 30(8): 30-33. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: The authors describe a cost-effective program for providing chimpanzee enrichment that at the same time educates the local community about the care of these animals in research.
Descriptors: animal welfare, laboratory animals, cost-benefit analysis, diet, education, housing, chimps, *Pan troglodytes*, social behavior, toys.

Howell, S., E. Roeder, C. Nelson, J. Fritz, and M. Schwandt (2002). **The effect of music on the behavior of captive chimpanzees (*Pan troglodytes*).** *American Journal of Primatology* 57(Suppl. 1): 83-84. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: scan sampling, focal behavior, aggression, exploration, calming effect of soft vocal music, social behavior, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, 1 June to 4 June 2002.

Howell, S., M. Schwandt, J. Fritz, K. Ossi, and E. Cobb (2003). **Customizing an environmental enrichment program for captive chimpanzees (*Pan troglodytes*) at the Primate Foundation of Arizona**. *American Journal of Primatology* 60 (Suppl. 1): 96. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimpanzees, *Pan troglodytes*, animal care, environmental enrichment program, feeding enrichment, rearing effects, sex effects, socially housed population, stationary furnishing, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Howell, S., M. Schwandt, J. Fritz, E. Roeder, and C. Nelson (2003). **A stereo music system as environmental enrichment for captive chimpanzees**. *Lab Animal* 32(10): 31-36. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: Music has been shown to have beneficial effects on humans but little is known about the effects of music on nonhuman primates in biomedical research settings. The authors monitored the effects of music on the behavior of captive chimpanzees and found that music had significant positive effects, including a reduction in agitated and aggressive behaviors.
Descriptors: reduction in aggression, agitation, and anxiety, effects of music on behavior, chimpanzees, *Pan troglodytes*, controlled study, environmental enrichment.

Howell, S., M. Schwandt, J. Fritz, and S. Walker (2002). **From laboratory to more natural enclosures: Maintaining the well-being of captive chimpanzees (*Pan troglodytes*)**. *Laboratory Primate Newsletter* 41(4): 5-9. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn41-4.html
NAL Call Number: SF407.P7 L3
Descriptors: Chimpanzee Health Improvement, Maintenance and Protection (CHIMP) Act, effect of environment on behavior, well-being, enriched environment, complexity, USA.

Jensvold, M.L.A., C.M. Sanz, R.S. Fouts, and D.H. Fouts (2001). **Effect of enclosure size and complexity on the behaviors of captive chimpanzees (*Pan troglodytes*)**. *Journal of Applied Animal Welfare Science* 4(1): 53-69. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: chimpanzees, *Pan troglodytes*, floor space, physical activity, locomotion, posture, animal welfare, cages, design, environmental enrichment.

Jones, P., R. Cantrell, and M. Chaplin (2004). **Enriching your enrichment program**. *Animal Keepers' Forum* 31(10): 430-436. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: gorillas, enrichment framework, naturalistic exhibits, puzzle feeders, mesh boxes, bungees, rope braiding, Disney's Animal Kingdom, Orlando, Florida, USA.

Kinder, T. (2003). **Demographic differences in the use of an enrichment device among zoo living western lowland gorillas (*Gorilla gorilla gorilla*)**. *American Journal of Primatology* 60 (Suppl. 1): 128. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: gorillas, *Gorilla gorilla gorilla*, PVC puzzle feeders, novelty, social behavior, object

manipulation, age effects, gender effects, meeting abstract.
Notes: 26th Annual Meeting of The American Society of Primatologists, Alberta, Canada; 30 July to 2 August 2003.

Lambeth, S., M. Bloomsmith, K. Baker, J. Perlman, M. Hook, and S. Schapiro (2001). **Control over videotape enrichment for socially housed chimpanzees: subsequent challenge tests.** *American Journal of Primatology* 54(Suppl. 1): 62-63. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimpanzees, *Pan troglodytes*, animal care, social behavior, solitary play, stress, videotape enrichment use by chimps, psychological well-being, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Lambeth, S.P., J. Hau, J.E. Perlman, M. Martino, and S.J. Schapiro (2006). **Positive reinforcement training affects hematologic and serum chemistry values in captive chimpanzees (*Pan troglodytes*)** . *American Journal of Primatology* 68(3): 245-256. ISSN: 1098-2345.
NAL Call Number: QL737.P9A5
Descriptors: positive reinforcement training, stress reduction, behavioral management, *Pan troglodytes*, injection training, hematology and serum chemistry profiles, physiological measures, chimpanzees.

Leyendecker, M. and U. Magiera (2001). **Lebensraumbereicherung bei adulten orang-utans, *Pongo pygmaeus*, im zoo. [Living space enrichment for adult orangutans, *Pongo pygmaeus*, in the zoo]**. *Zoologische Garten* 71(3): 173-193. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: environmental enrichment, adult orangutans, *Pongo pygmaeus*, feeding enrichment, object manipulation, food boxes, juice feeders, roof-feeding, seeds, decrease in antagonistic and abnormal behaviors.
Language of Text: German; Summary in English.

Lukas, K.E., M.P. Hoff, and T.L. Maple (2003). **Gorilla behavior in response to systematic alternation between zoo enclosures.** *Applied Animal Behaviour Science* 81(4): 367-386. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: complex naturalistic enclosures, behavioral data collection, animal behavior, use of exhibit space, novelty, environmental enrichment, Zoo Atlanta, Atlanta, Georgia, USA.

Martin, J.E. (2005). **The effects of rearing conditions on grooming and play behaviour in captive chimpanzees**. *Animal Welfare* 14(2): 125-133.
Descriptors: rearing background, psychological well-being, chimps, zoos, social behavior.

Mentz, I. and K. Perret (1999). **Environmental enrichment bei Flachlandgorillas (*Gorilla g. gorilla*) - Beobachtungen zur Nahrungsaufnahme und zum Manipulationsverhalten. [Environmental enrichment in gorillas (*Gorilla gorilla*): observations on feeding behavior and manipulation of food]**. *Zoologische Garten* 69(1): 49-63. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: *Gorilla gorilla gorilla*, gorillas, behavioral enrichment, tool use in connection with feeding, feeding enrichment, food boxes, raisin sticks, psychological well-being, Muenster Zoo, Germany.
Language of Text: German; Summary in English and German.

Morimura, N. (2003). **A note on enrichment for spontaneous tool use by chimpanzees (*Pan troglodytes*)**. *Applied Animal Behaviour Science* 82(3): 241-247. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: chimpanzees, *Pan troglodytes*, provision of choice to captive animals, well-being, feeding enrichment, voluntary tool-use, tube feeders, juice, behavioral freedom.

Nakamichi, M. and E. Kato (2001). **Long-term proximity relationships in a captive social group of western lowland gorillas (*Gorilla gorilla gorilla*)**. *Zoo Biology* 20(3): 197-209. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: gorillas, *Gorilla gorilla gorilla*, endangered species, zoo animals, animal behavior, gender and age effects, group interaction, aggressive behavior.

Neu, K., S. Lambeth, E. Toback, and S. Schapiro (2001). **Hay can be used to decrease feces smearing in groups of captive chimpanzees**. *American Journal of Primatology* 54(Suppl. 1): 78. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimps, *Pan troglodytes*, abnormal behavior, animal housing, behavioral enrichment, reduction in feces smearing, hay, meeting abstract.
Notes: 24th Annual Meeting of the American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Neuwald, A. and B.U. Heckner (2000). **Neue wege in der haltung von flachland gorillas, *Gorilla gorilla gorilla* (Savage and Wyman, 1847) im loro parque teneriffa. [A new way of keeping lowland gorillas, *Gorilla gorilla gorilla* (Savage and Wyman, 1847) in Loro Park, Tenerife]**. *Zoologische Garten* 70(6): 376-402. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: *Gorilla gorilla gorilla*, male gorillas, dominance hierarchies, enclosure design and size, bachelor group dynamics, play behavior, social interactions, social structure, Loro Parque, Tenerife.
Language of Text: German; Summary in English and German.

Ochiai, O.T. and T. Matsuzawa (2001). **Introduction of two wooden climbing frames as environmental enrichment for captive chimpanzees (*Pan troglodytes*) and its assessment.** *Japanese Journal of Animal Psychology* 51(1): 1-9. ISSN: 0916-8419.
Descriptors: chimpanzees, *Pan troglodytes*, well-being, three-dimensional space, provision of wooden climbing frames, activity budgets, spacing patterns.

Ross, S.K., M.A. Bloomsmith, K.C. Baker, and W.D. Hopkins (2000). **Initiating a computer-assisted enrichment system for captive chimpanzees**. *American Journal of Primatology* 51(Suppl. 1): 86-87. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Pan troglodytes*, chimpanzees, modified computer-joystick system, patterns of use, task learning in captive chimps, activity budgets, food rewards, age effects, lack of habituation, meeting abstract.
Notes: 23rd Annual Meeting of The American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Ross, S.R., M.A. Bloomsmith, and S.P. Lambeth (2003). **Early rearing and the social development of captive chimpanzees: Interactions with social partners.** *American Journal of Primatology* 60(Supplement 1): 39. ISSN: 0275-2565.
Descriptors: chimpanzees, *Pan troglodytes*, social development, captive breeding, early rearing environment, group size and composition, play behavior, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 02, 2003.

Ross, S.R. and K.E. Lukas (2001). **The care and management of captive chimpanzees workshop: Managing social behavior**. *Journal of Applied Animal Welfare Science* 4(4): 299-301. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: chimpanzees as laboratory and zoo animals, *Pan troglodytes*, group size, artificial rearing, social behavior, aggressive behavior, training of animals, conference report.

Sanz, C., A. Blicher, K. Dalke, L. Gratton Fabbri, T. McClure Richards, and R.S. Fouts (1999). **Use of temporary and semipermanent enrichment objects by five chimpanzees**. *Journal of Applied Animal Welfare Science* 2(1): 1-11. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: chimpanzees, *Pan troglodytes*, manipulanda, cargo nets, climbing structures, treat mounds, physical activity, social behavior, animal husbandry, animal welfare, social dominance.

Schnapp, N. (2001). **Primate centre promises insight into ape research**. *Nature* 410(6829): 618. ISSN: 0028-0836.
Descriptors: apes, animal welfare, zoo exhibits, public opinion, research on intelligence, cognitive abilities, tool-using, numerical skills and social behavior, Wolfgang Köhler Primate Research Centre, Zoo Leipzig, Germany.

Seiver, D., P. Walsh, B. Weber, and M. MacPhee. (2001). **Operant conditioning of apes to facilitate medical procedures and immobilizations**. In: *The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo, Brookfield, IL,* Chicago Zoological Society: Chicago, Illinois, USA, p. 137-139. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACSeiver.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: apes, positive reinforcement training, animal behavior, husbandry training, immobilizations, administration of medication.

Sendall, C., A. Melin, and J. Paterson (2003). **Social and environmental enrichment in a captive troop of western lowland gorillas (*Gorilla gorilla gorilla*)**. *American Journal of Primatology* 60 (Suppl. 1): 54. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Gorilla gorilla gorilla*, gorilla social relationships, focal animal sampling, socialization, effects of introduction on behavior, Calgary Zoo, Canada, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Smith, K., T. Tobery, and J. Erwin (2003). **Use of space and manipulable objects in chimpanzees: Individual differences in response to environmental enrichment.** *American Journal of Primatology* 60 (Suppl. 1): 80. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Pan troglodytes*, blanket use by chimpanzees, conspecific contact, environmental enrichment response, manipulable objects, sleeping sites, social contact, space use, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Stoinski, T.S., N. Czekala, K.E. Lukas, and T.L. Maple (2002). **Urinary androgen and corticoid levels in captive, male Western lowland gorillas (*Gorilla g. gorilla*): Age and social group related differences**. *American Journal of Primatology* 56(2): 73-87. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Urinary androgen and corticoid levels were measured for 52 captive male Western lowland gorillas to examine age-related variance and potential differences resulting from various social situations. Significant diurnal variation was present in both hormones. Age-related differences in androgens revealed that males experienced two stages of androgen increase and one stage of decrease: increases occurred from juvenile (less than 10 yr of age) to subadult (between 10-13 yr) and subadult to young adult (14-20 yr), whereas decreases occurred from young adult to adult (> 20 yr). Age-related differences in corticoid levels varied depending on the time of day, but morning corticoids were greatest in juvenile males, followed by young adult males. The type of social grouping was associated with differences in corticoid levels, as animals housed socially (in either a heterosexual or all-male group) had similar corticoid levels, whereas solitary males showed greater corticoid levels than their socially-housed counterparts. The

increased levels of corticoids in solitary-housed males suggest this management strategy might not be optimal, although more data are needed. Additionally, the significantly greater levels of androgens and corticoids in young adult male gorillas may present management challenges, and thus zoos may need to consider increasing the flexibility of their current management practices with respect to males.
Descriptors: captive male gorillas in zoos, *Gorilla gorilla gorilla*, social housing, circadian rhythm, stress, age differences, effects of social situation on androgen and corticoid levels, single housing, management strategies.

Tarou, L., M.P. Hoff, M.A. Bloomsmith, and T.L. Maple (2001). **A longitudinal examination of aging in Western lowland gorillas (*Gorilla gorilla gorilla*)**. *American Journal of Primatology* 54(Suppl. 1): 93-94. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Gorilla gorilla gorilla*, aging in gorillas, environmental enrichment, locomotion, object manipulation, social contact, meeting abstract.

Tarou, L.R., L. Mayo, a.M. Stone, D. Adcock, C.W. Kuhar, M.a. Bloomsmith, and T.L. Maple (2002). **Computer-assisted enrichment for zoo-housed orangutans (*Pongo pygmaeus*)**. *American Journal of Primatology* 57(Suppl. 1): 84. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: computer-joystick system, animal behavior, lack of habituation, increases in stress-related behaviors, aggression, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4,2002.

Tecot, S., M.L. Jensvold, and R. Fouts (1999). **Evaluation of an enriched physical environment: Space and structure utilization in *Pan troglodytes***. *American Journal of Physical Anthropology* (Suppl. 28): 264. ISSN: 0002-9483.
Descriptors: *Pan troglodytes*, chimp behavior, environmental enrichment, social housing, spatial complexity, structure utilization, meeting abstract.
Notes: 68th Annual Meeting of the American Association of Physical Anthropologists, Columbus, Ohio, USA; April 26-May 1, 1999.

Ujhelyi, M., B. Merker, P. Buk, and T. Geissmann (2000). **Observations on the behavior of gibbons (*Hylobates leucogenys, H. gabriellae*, and *H. lar*) in the presence of mirrors**. *Journal of Comparative Psychology* 114(3): 253-262. ISSN: 0735-7036.
Abstract: Three captive gibbons (*Hylobates leucogenys, H. gabriellae, and H. lar*) were videotaped in the course of longitudinal exposure to mirrors introduced into their familiar cage or island housing situation. The gibbons, which differed in age, sex, species, and rearing condition, exhibited great individual differences in their behavioral reactions to mirrors, spanning from a minimal reaction dominated by social responses to a dramatic sequence of progressive behavioral change that featured a variety of contingency testing behaviors and included mirror-mediated, self-directed behavior. Additional information on the mirror competence of gibbons was provided by modified mark tests and a hidden object task. The results are discussed in relation to current criteria for self-recognition in primates and factors involved in individual and species differences in reactions to mirror exposure.
Descriptors: gibbons, *Hylobates sp.*, exploratory behavior, reaction to mirrors based on age, sex, species and rearing background, hidden object task, modified mark task, videotaped behavior, social behavior, concept of self, species specificity.

Valdovinos, E. (2001). **Effects of enrichment items on the Sacramento Zoo orangutans**. *Animal Keepers' Forum* 28(9): 354-364. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: *Pongo pygmaeus*, orangutans, environmental enrichment in zoos, interspecific competition, Sacramento Zoo, California, USA.

Videan, E.N., J. Fritz, M.L. Schwandt, H.F. Smith, and S. Howell (2005). **Controllability in environmental enrichment for captive chimpanzees (*Pan troglodytes*)**. *Journal of Applied Animal Welfare Science* 8(2): 117-130. ISSN: 1088-8705.
Online: http://www.psyeta.org/jaaws/
NAL Call Number: HV4701.J68
Abstract: This study considers the use of nonsocial environmental enrichment by captive chimpanzees at the Primate Foundation of Arizona. The goal was to determine whether a relationship existed between controllability of enrichment items by captive chimpanzees and frequency of use. The study measured controllability, the ability of nonhuman animals to alter aspects of their environment by the potential destructibility of the enrichment item. This study examined additional factors that may affect enrichment use: individual age, sex, rearing history, social group composition, and availability of outdoor access. The chimpanzees in the study used destructible items-the enrichment category with the highest level of controllability-more than indestructible items across all age, sex, and rearing classes. Thus, controllability seems to be an important factor in chimpanzee enrichment. Younger individuals and groups with outdoor access used enrichment more than did older individuals and groups with indoor-only access. Individual sex, rearing history, and social group composition had minimal effects on enrichment use. These results support the importance of control to captive chimpanzees and further enable captive management to customize enrichment programs to the needs of particular animals.
Descriptors: captive wild animals, chimps, *Pan troglodytes*, Primate Foundation of Arizona, controllability of enrichment items, frequency of use of environmental enrichment, destructibility of toys, life history differences, age differences, customizing enrichment programs.

Visalberghi, E., M.M. Yamakoshi, S. Hirata, and T. Matsuzawa (2002). **Responses to novel foods in captive chimpanzees**. *Zoo Biology* 21(6): 539-548. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: *Pan troglodytes*, feeding behavior, ingestion of novel foods, fearfulness, social facilitation, laboratory animals, animal preferences, prediction, human-animal relationships, environmental enrichment, feeding enrichment.

Warne, S.P. and D.M. Broom (2002). **Behavioural responses in captive gorillas following changes to their physical and social environment**. *Advances in Ethology* 37: 91. ISSN: 0301-2808.
NAL Call Number: 410 Z35B
Descriptors: gorillas, abnormal behavior, behavioral data collection, environmental manipulation, activity budgets, coping responses, animal welfare.
Notes: 4th International Symposium on Physiology and Behaviour of Wild and Zoo Animals, Berlin, Germany; September 29-October 2, 2002.

Weghorst, J.A. and W.C. Mcgrew (2000). **Up where they belong? Habitat use and activity budget in two captive groups of western lowland gorilla (*Gorilla gorilla gorilla*)**. *Zoologische Garten* 70(5): 273-284. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: gorillas, *Gorilla gorilla gorilla*, activity budgets, behavioral stimulation, captive groups, three dimensional space compared to two dimensional space, differences in arboreality, zoo habitat use, Columbus Zoo, Cincinnati Zoo, USA.
Language of Text: German; Summary in English and German.

Wells, D.L. and E.C. Blaney. (2003). **Camouflaging gorillas: A method of reducing the 'visitor effect'**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 332-333.
Descriptors: gorillas, *Gorilla gorilla*, zoo housing and exhibiting techniques, aggressive behavior, abnormal behavior, stereotypic behavior, camouflage net barrier, visitor effects on behavior.

Whittaker, M., G. Laule, J. Perman, S. Shapiro, and M. Keeling. (2001). **A behavioral management approach to caring for great apes**. In: *The Apes: Challenges for the 21st Century, May 10-13,*

2000, Brookfield Zoo, Brookfield, IL, Chicago Zoological Society: Chicago, Illinois, USA, p. 131-134. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACWhittaker.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: great apes, enrichment, animal welfare, positive reinforcement training, captive management, behavioral management program.

Williams, H. (2003). **Orang utan enrichment.** In: *Annual Symposium on Zoo Research: 2002, July 8-9, 2002, Bristol Zoo Gardens, UK,* The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 32.
Online: http://www.biaza.org.uk/resources/library/images/ARSP4.pdf
Descriptors: puzzle feeders, increase in active behaviors, indoor winter housing, arboreal behaviors, sticks, age differences, social group of mixed sex and age, abstract only.

Woods, S. (2000). **Spontaneous tool behaviors in a captive group of gorillas (*Gorilla gorilla gorilla*): Innovation and observational learning**. *American Journal of Primatology* 51(Suppl. 1): 99. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: gorillas, *Gorilla gorilla gorilla*, neural coordination, behavioral enrichment, food acquisition, observational learning, social interactions, spontaneous tool use, meeting abstract.
Notes: 23rd Annual Meeting of the American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Zambetta, K. (2005). **Sex, age, and life history differences in the utilization of enrichment in captive lowland gorillas.** *American Journal of Physical Anthropology* 126(S40): 229. ISSN: 0002-9483.
Descriptors: gorillas, behavioral ecology, use of environmental enrichment, captive environments, psychological well-being, rearing history, age and sex differences, life history differences, meeting abstract.
Notes: 74th Annual Meeting of the American Association of Physical Anthropologists, Milwaukee, Wisconsin, USA; April 6 -9, 2005.

Macaques

Alexander, S. and M. Fontenot (2003). **Isosexual social group formation for environmental enrichment in adult male *Macaca mulatta***. *Contemporary Topics in Laboratory Animal Science* 42(4): 122. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: rhesus macaques, *Macaca mulatta*, alternative to single housing, self-injurious behavior (SIB), behavioral observations, group formation, rhesus macaques, meeting abstract.

Asvestas, C. and M. Reiniger (1999). **Forming a bachelor group of long-tailed macaques (*Macaca fascicularis*)**. *Laboratory Primate Newsletter* 38(3): 14-15. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn38-3.html
NAL Call Number: SF407.P7 L3
Descriptors: process of socialization, formation of all-male group, reduction in stereotypic behavior, description of group introduction, lip-smacking, establishment of hierarchy, trees, outside habitat, cynomolgus macaques.

Augustsson, H. and J. Hau (1999). **A simple ethological monitoring system to assess social stress in group-housed laboratory rhesus macaques**. *Journal of Medical Primatology* 28(2): 84-90. ISSN: 0047-2565.
NAL Call Number: QL737.P9J66
Abstract: The increasing awareness of the importance of social housing of laboratory primates results in the establishment of group housing in many facilities. Our aim was to develop a set of manageable tools to allow continuous monitoring of social relations within groups and to establish an objective, scientific ground on which changes in group composition could be based. We studied 38 adult rhesus monkeys (*Macaca mulatta*) grouped as five one-male/multi-female groups using focal sampling. We recorded the occurrence and direction of aggressive and non-aggressive social interactions as well as time spent inactive in proportion to social contacts, feeding and other activities. The present analysis clearly identified low-ranking animals with none or few affiliative contacts and who also spent much time inactive and separated from other low-ranking animals. This suggests that the present approach results in useful information concerning compatibility between group members and enables identification of animals experiencing high social stress.
Descriptors: primates as laboratory animals, adult rhesus macaques, *Macaca mulatta*, social behavior, mixed sex groups, monitoring of social relations in group housed animals, levels of aggression, assessing compatibility for social housing, social hierarchy ranking, animal welfare, social isolation.

Badihi, I. (2000). **Effect of environmental enrichment on the welfare of long-tailed macaque (*Macaca fascicularis*) infants separated from their mothers**. *Israel Journal of Zoology* 46(2): 156-157. ISSN: 0021-2210.
Descriptors: cynomolgus macaques, *Macaca fascicularis*, animal welfare, effects of enriched environments on weaned animals, parental separation, behavioral development, rearing environment.

Baker, K., M. Bloomsmith, C. Griffis, and M. Gierhart (2003). **Self injurious behavior and response to human interaction as enrichment in rhesus macaques**. *American Journal of Primatology* 60 (Suppl. 1): 94-95. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-injurious behavior (SIB), abnormal behavior, vocalizations, human interaction as environmental enrichment, *Macaca mulatta*, rhesus macaques, stress.

Blanchard, M., S. Gruver, P. Kirk, V. McLain, and M. Zebrun (2005). **Look what's hanging around! Foraging feeder cup puzzles for cynomolgus macaques**. *Tech Talk* 10(3): 3.

Online: http://www.aalas.org/pdfUtility.aspx?pdf=TT/10_3.pdf
Descriptors: cynomolgus macaques, feeder cup puzzle, feeding daily rations with enrichment device, challenge puzzle, time spent foraging.

Blaszkiewitz, B. (2004). **Die neue anlage fur japanmakaken (*Macaca fuscata*) im tierpark berlin-friedrichsfelde. [The new enclosure for Japanese macaques (*Macaca fuscata*) at Tierpark Berlin-Friedrichsfelde]**. *Zoologische Garten* 74(2): 77-80. ISSN: 0044-5169.
NAL Call Number: 410 Z724
Descriptors: Japanese macaques, primates in zoo settings, environmental enrichment, inclusion of rocks, trees and pond in new enclosure, replacement of cages with naturalistic exhibits, Tierpark Berlin-Friedrichsfelde, Germany.
Language of Text: German; Summary in English.

Brannon, E., M. Andrews, and L. Rosenblum (2004). **Effectiveness of video of conspecifics as a reward for socially housed bonnet macaques (*Macaca radiata*)**. *Perceptual and Motor Skills* 98(3-1): 849-858. ISSN: 0031-5125.
Descriptors: type of reward in cognitive task, reward value of video, video of novel versus familiar social group, response rates, individual differences, socially housed macaques, bonnet macaques, *Macaca radiata*.

Crockett, C.M., R.U. Bellanca, D.R. Koberstein, and D. Shaw (2002). **A protective "puzzle ball loader" for safe provisioning**. *Laboratory Primate Newsletter* 41(1): 1-3. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn40-1.html#worm
NAL Call Number: SF407.P7 L3
Descriptors: personnel safety risks, macaques, foraging devices, environmental enrichment item safety, storage receptacle, protective device, parts and assembly, puzzle ball loading.

Crockett, C.M., M. Shimoji, and D.M. Bowden (2000). **Behavior, appetite, and urinary cortisol responses by adult female pigtailed macaques to cage size, cage level, room change, and ketamine sedation**. *American Journal of Primatology* 52(2): 63-80. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Pigtailed macaques (*Macaca nemestrina*) and longtailed macaques (*M. fascicularis*) show behavioral, ecological, and possible temperament differences, and their responses to the laboratory environment might therefore be quite different. We tested pigtailed macaques under the same conditions that were investigated in a previous study with longtailed macaques, using the same comprehensive set of physiological and behavioral measures of stress. First, eight adult females' adaptation to a new room in regulation-size cages was monitored, and in the third week their responses to ketamine sedation were measured. Then they spent two weeks singly housed in each of four cage sizes (USDA regulation size, one size larger, one size smaller, and a very small cage). Half of the subjects were in upper-level cages and the remainder in lower-level cages for the entire study. Cage size, ranging from 20% to 148% of USDA regulation floor area, was not significantly related to abnormal behavior, self-grooming, manipulating the environment, eating/drinking, activity cycle, cortisol excretion, or biscuit consumption. Locomotion and frequency of behavior change were significantly reduced in the smallest cage, but did not differ in cage sizes ranging from 77% to 148% of regulation size. The only manipulation to produce an unequivocal stress response, as measured by cortisol elevation and appetite suppression, was ketamine sedation. Room change and cage changes were associated with minimal cortisol elevation and appetite suppression. Wild-born females showed more appetite suppression after room change than captive-born females. No differences were related to cage level. Pigtailed macaques strongly resembled longtailed macaques except they showed weaker responses to the new room and cage change, probably because the pigtails had spent more time in captivity. These findings support the conclusion that increasing cage size to the next regulation size category would not have measurable positive effects on the psychological well-being of two species of laboratory macaques.
Descriptors: effects of increased cage size, time in captivity, species comparison, cortisol elevation, feeding suppression, *Macaca fascicularis*, long-tailed macaques, *Macaca nemestrina*,

pigtailed macaques, anesthetics, animal behavior, laboratory animal housing, circadian rhythm.

Deck, J.W., T. Gipe, J. Pizzaia, and W. Shotwell (2005). **Foraging device for cynomolgus macaques**. *Tech Talk* 10(3): 1-2.
Online: http://www.aalas.org/pdfUtility.aspx?pdf=TT/10_3.pdf
Descriptors: cynomolgus macaques, foraging device, ability to be sanitized, cage washer, novely foods, pair housing.

Florence, G. and L. Riondet (2000). **Effets d'une mangeoire en forme de labyrinthe sur le comportement du macaque rhesus: Phase d'apprentissage. [Influence of a puzzle feeder on rhesus macaque behaviour: Learning phase]**. *Folia Primatologica* 71(4): 256-257. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: foraging devices, puzzle feeders, effect of puzzle feeders on stereotypic and saluting behaviors, environmental enrichment, singly-housed monkeys, rhesus macaques, *Macaca mulatta*, self-injurious behavior, meeting abstract.
Language of Text: French; Summary in English.
Notes: 11th Annual Meeting of the Societe Francophone de Primatologie, Paris, France; September 29-October 2, 1999.

Friscino, B., C. Gai, A. Kulick, M. Donnelly, R. Rokar, L. Anderson, and S. Iliff (2003). **Positive reinforcement training as a refinement of a macaque biliary diversion model**. *Contemporary Topics in Laboratory Animal Science* 42(4): 80. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: macaques, refinement techniques, bile duct diversion, animal models, positive reinforcement training, blood and bile collection, jacket-training, cannula system, pouch presentation, time taken to train animals, effect on stress, meeting abstract.
Notes: 2003 AALAS National Meeting, Seattle, Washington, USA; October 12-16, 2003.

Hahn, N.E., D. Lau, K. Eckert, and H. Markowitz (2000). **Environmental enrichment related injury in a macaque (*Macaca fascicularis*): Intestinal linear foreign body**. *Comparative Medicine* 50(5): 556-558. ISSN: 1532-0820.
NAL Call Number: SF77 .C65
Abstract: A three-year old male cynomolgus macaque (*Macaca fascicularis*) presented with clinical signs of anorexia and depression that decreased over a 48-hour period. Results of abdominal radiography abdominocentesis, blood biochemical analysis and CBC suggested septic peritonitis. Exploratory laparotomy revealed multiple perforations along the mesenteric border of the small intestine. Necropsy revealed masses of fibrous material in the stomach and cecum. Multiple mucosal ulcerations, as well as linear fibrous material, were found in the small intestine. The ulceration, perforations, and septic peritonitis were attributed to the ingestion of rope that had been attached to the animal's cage as an environmental-enrichment device.
Descriptors: long-tailed macaque, *Macaca fascicularis*, clinical signs of anorexia and depression, fatal outcome after ingestion of rope, septic peritonitis, perforation of small intestine, rope as environmental enrichment.

Harris, L.D., E.J. Briand, R. Orth, and G. Galbicka (1999). **Assessing the value of television as environmental enrichment for individually housed rhesus monkeys: A behavioral economic approach.** *Contemporary Topics in Laboratory Animal Science* 38(2): 48-53. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: The goal of this study was to evaluate television as a source of environmental enrichment for individually housed rhesus monkeys (*Macaca mulatta*) by using the concepts of behavioral economics. Phase I entailed the use of operant conditioning to assess the behavior of eight rhesus monkeys given the opportunity to control their environment through lever activation of a television (TV). Success in shaping was variable, and only two animals successfully acquired lever pressing. Phase II used an alternating reinforcement/ extinction procedure as a control

method to determine the degree to which lever pressing depended on TV presentation. Both animals responded with more lever pressing on the days when lever pressing produced TV. The first animal, tested with the alternating reinforcement/extinction procedure for 12 weeks yielded a mean significant difference of 3.85 ($p = 0.036$); the second assessed for 9 weeks was associated with a mean significant difference of 6.0 ($p = 0.018$). Therefore, TV (and not lever pressing itself) was positively reinforcing. The final phase of the study progressively increased the fixed ratio (FR) from 1 to 8. Linear regression of the data points, plotted as the log of price (or FR) vs the consumption of TV, revealed a significantly negative slope (-2.179, p, 0.05) and accounted for 89% of the variance. The negative demand curve suggested that TV is not a valued commodity and is highly elastic. TV provided to individually housed rhesus monkeys appears to be a weakly positive reinforcer for some animals, which may contribute to overall environmental enrichment.
Descriptors: *Macaca mulatta*, rhesus macaque, operant conditioning, animal control of television viewing, shaping behavior, positive reinforcement training, single housing.

Hartner, M., J. Hall, J. Penderghest, and L.P. Clark (2001). **Group housing subadult male cynomolgus macaques in a pharmaceutical environment**. *Lab Animal* 30(8): 53-57. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: The authors describe the preliminary results of a program to group-house male cynomolgus monkeys. Using a unique cage design, they were able to achieve environmental enhancement and enrichment that led to easier handling of the animals used in protocols for pharmacological research.
Descriptors: group housing, social environment, *Macaca fascicularis*, male long-tailed macaques, cage design to facilitate animal handling, environmental enrichment, pharmocological research protocol, animal well-being.

Honess, P., J. Gimpel, S. Wolfensohn, and G. Mason (2005). **Alopecia scoring: The quantitative assessment of hair loss in captive macaques**. *Alternatives to Laboratory Animals* 33(3): 193-206. ISSN: 0261-1929.
NAL Call Number: Z7994.L3A5
Abstract: Many captive animals show forms of pelage loss that are absent in wild or free-living conspecifics, which result from grooming or plucking behaviours directed at themselves or at other individuals. For instance, dorsal hair loss in primates such as rhesus macaques (*Macaca mulatta*) in research facilities, results from excessive hair-pulling or over-grooming by cage-mates. This behaviour appears to be associated with stress, and is controllable to some extent with environmental enrichment. Quantifying alopecia in primates (as in many species) is therefore potentially useful for welfare assessment. A simple system for scoring alopecia was developed and its reliability was tested. Study 1 showed high interobserver reliability between two independent scorers in assessing the state of monkeys coats from photographs. Study 2 showed that there were no significant differences between the scores derived from photographs and from direct observations. Thus, where hair loss due to hair pulling exists in captive primates, this scoring system provides an easy, rapid, and validated quantitative method, for use in assessing the success of attempts to reduce it via improved husbandry. In the future, such scoring systems might also prove useful for quantifying barbering in laboratory rodents.
Descriptors: rhesus macaques, *Macaca mulatta*, grooming or plucking behaviors, primates in captive environments, quantifying hair loss (alopecia), welfare assessment using hair loss measurements, development of alopecia scoring system.

Honess, P.E., P.J. Johnson, and S.E. Wolfensohn (2004). **A study of behavioural responses of non-human primates to air transport and re-housing**. *Laboratory Animals* 38(2): 119-132. ISSN: 0023-6772.
NAL Call Number: QL55.A1L3
Abstract: More long-tailed macaques (*Macaca fascicularis*) than any other primate are imported into the UK for research, and journey times may be of up to 58 h. Whilst a number of studies have examined the stress associated with transport, these have typically involved laboratory rodents and livestock, and little is known of its effect on non-human primates. This paper reports the results of a study of behavioural changes in a group of long-tailed macaques transported by air

from standard breeding conditions and then re-housed in standard laboratory primate conditions. The animals were studied prior to their departure, immediately after their arrival, and 3 weeks after that. Data were collected on individual time budgets using focal animal sampling and on hierarchy using a feeding trial. The data were analysed for changes in behavioural repertoires and for social perturbation that would be reflected in hierarchical changes. Changes in behaviour occurred which reflected heightened levels of stress in the study group. It was also clear that although there was some adjustment of behaviour, after an initial change on arrival at the new establishment, there was no return to levels observed at the breeding facility within the first month. This study demonstrates that, as a whole, the process of international air transport and re-housing in laboratory conditions may result in the compromising of the welfare of the study animals.
Descriptors: male cynomologus macaques, *Macaca fascicularis*, United Kingdom, transportation stress, behavioral time budgets, housing changes, laboratory conditions, international air transport, animal welfare.

Hotchkiss, C.E. and M.G. Paule (2003). **Effect of pair-housing on operant behavior task performance by rhesus monkeys**. *Contemporary Topics in Laboratory Animal Science* 42(4): 38-41. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: This study evaluated the effects of pair-housing on several operant (trained) behaviors in rhesus macaques (*Macaca mulatta*). Sixteen young, male, individually housed rhesus monkeys (age, 2.5 to 5.5 years) performed a battery of behaviors consisting of motivation (progressive ratio, PR), short-term memory and attention (delayed matching-to-sample, DMTS), color and position discrimination (conditioned position responding, CPR), and learning (incremental repeated acquisition, IRA) tasks. Behavioral assessments occurred 5 days/week, with the PR, IRA, and CPR tasks presented on one test day, and the DMTS task presented on the next test day. Thus, each task was performed two or three days/week. Eight subjects then were pair-housed, while eight age-matched controls remained individually housed. Pair-housed monkeys were separated for behavior testing and feeding but allowed access to each other approximately 20 h/day. The performance of the two groups of monkeys were compared for the 2 months prior to pairing, for a 2-month transition period as the pairs adjusted to the new housing situation, and for a 2-month period after the pairs had been established. Performance of the CPR and IRA tasks did not change over time in either group. For the PR and DMTS tasks, the number of trials completed increased over the course of the study in the controls but not in the pair-housed monkeys. In conclusion, pair-housing monkeys is feasible for studies involving operant behavior testing as a model for a variety of complex brain functions. However, housing condition may affect some test parameters, and this must be taken into consideration during experimental design.
Descriptors: juvenile male rhesus macaques, *Macaca mulatta*, effects of single housing versus pair housing on tasks, operant conditioning, learning, short-term memory, experimental design for studies of operant behavior.

Kaplan, J., M. Ayers, M. Phillips, C. Mitchell, C. Wilmoth, D. Cairnes, and M. Adams (2003). **The effect of non-nutritive environmental enrichment on the social behavior of group-housed cynomologus macaques (*Macaca fasicularis*)**. *Contemporary Topics in Laboratory Animal Science* 42(4): 117. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: long-tailed macaques, *Macaca fascicularis*, mirrors, rubber toys, chains, group housing, behavioral observations, aggression, meeting abstract.
Notes: 2003 AALAS National Meeting, Seattle, Washington, USA; October 12-16, 2003.

Kiyama, A., A.J. Taylor, J.L. McCarty, and F.A.W. Wilson (2003). **A video-display approach to environmental enrichment for macaques**. *Laboratory Primate Newsletter* 42(3): 1-3. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn42-3.html
NAL Call Number: SF407.P7 L3

Descriptors: bar press, video as environmental enrichment, images, novel visual stimuli, animal behavior, macaques.

Magee, N. (2003). **An investigation into environmental enrichment with Sulawesi crested macaques (*Macaca nigra*) at Paignton Zoo Environmental Park**. In: *Annual Symposium on Zoo Research: 2002, July 8-9, 2002, Bristol Zoo Gardens, UK,* The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 33-37.
Online: http://www.biaza.org.uk/resources/library/images/ARSP4.pdf
Descriptors: Sulawesi crested macaques, *Macaca nigra*, comparison of four feeding devices, puzzle feeders, complexity of device manipulation, dried fruits, variable amount of time spent using devices, age differences, primates in zoo settings, Paignton Zoo Environmental Park, UK.

Mallapur, A., N. Waran, and A. Sinha (2005). **Use of enclosure space by captive lion-tailed macaques (*Macaca silenus*) housed in Indian zoos.** *Journal of Applied Animal Welfare Science* 8(3): 175-186. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: *Macaca silenus*, lion-tailed macaques, use of space, zoos and wildlife parks, housing techniques, zoo enclosure design, enclosure utilization, animal behavior, India.

McGuffey, L.H., C.L. McCully, B.J. Bernacky, and S.M. Blaney (2002). **Incorporation of an enrichment program into a study protocol involving long term restraint in macaques**. *Lab Animal* 31(10): 37-39. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: Nonhuman primates might experience stress during periods of restraint associated with research procedures. In an attempt to minimize such stress, the authors describe an enrichment program they designed for use with restrained adult male rhesus macaques.
Descriptors: husbandry methods, animal behavior, stress reduction program, protocols involving physical restraint, adult male rhesus macaques, *Macaca mulatta*, environmental enrichment.

Melfi, V.A. and A.T.C. Feistner (2002). **A comparison of the activity budgets of wild and captive Sulawesi crested black macaques (*Macaca nigra*)**. *Animal Welfare* 11(2): 213-222. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Macaca nigra*, Sulawesi macaques, captive wild animals, comparison study, endangered species, animal welfare, zoo animals, physical activity, social behavior, feeding behavior.

Melfi, V.A. and N. Marples (2000). **How different captive environments affect the behaviour of Sulawesi crested black macaques (*Macaca nigra*)**. In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 151-157.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: *Macaca nigra* , Sulawesi crested black macaques, activity budgets of captive animals, seven zoos, feeding behavior, effects of age, sex, UK, Ireland.

Merrill, D.A., E. Maslian, J.A. Roberts, L.C. Cork, D.L. Price, J. Kordower, E.J. Mufsion, and M.H. Tuszynski (2000). **Environmental deprivation causes accelerated amyloid plaque formation and reduction in synapse number in the aged primate brain.** *Society for Neuroscience Abstracts* 26(1-2): Abstract No. 181.12. ISSN: 0190-5295.
NAL Call Number: QP351.S6
Descriptors: environmental enrichment, social environment, single housing, cage size, social and manipulanda deprived environment, brain development, neurogenesis, aging, *Macaca mulatta*.

Morgan, D., K.A. Grant, O.A. Prioleau, S.H. Nader, J.R. Kaplan, and M.A. Nader (2000). **Predictors of social status in cynomolgus monkeys (*Macaca fascicularis*) after group formation**. *American Journal of Primatology* 52(3): 115-131. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: The purpose of the present study was to determine whether various behavioral and hormonal markers obtained in individually housed monkeys would be predictive of social rank following group housing. Body weight, serum cortisol and testosterone levels, and locomotor activity in an open-field apparatus were examined in 20 experimentally naive male cynomolgus monkeys (*Macaca fascicularis*) while they were individually housed. It was hypothesized that eventual subordinate monkeys would have higher cortisol levels and increased locomotor activity scores. These monkeys were then placed in social groups of four (five pens of four monkeys), and social rank was determined based on outcomes of dyadic agonistic encounters. Body weight correlated significantly with eventual social rank. In general, the heavier the monkey the higher the social rank. Locomotor activity in an open-field apparatus following administration of a low dose of cocaine (0.01 mg/kg, i.v.), which has been shown to increase CNS dopamine, correlated with eventual social rank such that individually housed monkeys with high levels of locomotion were more likely to become subordinate. Serum cortisol and testosterone levels failed to correlate with eventual social rank. Hypothalamic-pituitary feedback sensitivity and adrenal responsiveness were examined by measuring cortisol levels after administration of dexamethasone and following ACTH challenge. Cortisol responses in these tests were not associated with eventual social rank. These results suggest that, in addition to body weight, the level of reactivity in a novel environment after administration of a low dose of cocaine is a potential trait marker for social rank. This trait is apparently not associated with hormone levels, but may involve other CNS mechanisms.
Descriptors: social rank predicted by behavioral and hormonal markers, male long-tailed macaques, *Macaca fascicularis*, single housing into small social groups, cortisol levels, locomotor activity scores, effect of body weight on social rank, level of reactivity to novel environments, cocaine administration, aggression, hypothalamic-pituitary feedback sensitivity, adrenal responsiveness.

O'Neill-Wagner, P. (2003). **Social display, feeding, exploration, and program attentiveness rates for rhesus monkeys (*Macaca mulatta*) exposed to audio-visual programs**. *American Journal of Primatology* 60 (Suppl. 1): 119. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: environmental enrichment, single housing for veterinary care, animal behavior, attentiveness to videos, play and exploration, gender effects, age effects, retrospective analysis, meeting abstract.
Notes: 26th Annual Meeting The American Society of Primatologists, Alberta, Canada; July 30 to August 2, 2003.

Rawlins, J. (2005). **Stock tanks for yearlong primate enrichment**. *Tech Talk* 10(3): 1-2.
Online: http://www.aalas.org/pdfUtility.aspx?pdf=TT/10_3.pdf
Descriptors: rhesus macaques, swimming pools, social groups , bedding, foraging enrichment, stock tanks, Oregon National Primate Research Center.

Rawlins, J.M., S. Poerstel, and K. Coleman (2003). **Utilization of toy devices by rhesus macaques**. *Contemporary Topics in Laboratory Animal Science* 42(4): 123. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: rotation of enrichment toys, foraging manipulanda, focal observations, *Macaca mulatta*, meeting abstract.
Notes: 2003 AALAS National Meeting, Seattle, Washington, USA; October 12-16, 2003.

Reinhardt, V. (2005). **Implementing housng refinements in a rhesus macaque colony**. *Contemporary Topics in Laboratory Animal Science* 44(3): 76,78,80. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: laboratory animals, animal use refinement, cage design, group housing, animal

stress, training of animals, animal care, restraint of animals, blood sampling.

Reinhardt, V. (2003). **Legal loophole for sub-minimal floor area for caged macaques**. *Journal of Applied Animal Welfare Science* 6(1): 53-56. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: animal welfare legislation, reduced floor area in cages, laboratory animal housing, *Macaca* sp., United States.

Reinhardt, V. (1999). **Pair-housing overcomes self-biting behavior in macaques**. *Laboratory Primate Newsletter* 38(1): 4-5. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn38-1.html
NAL Call Number: SF407.P7 L3
Descriptors: abnormal behavior, self-biting, compatible social housing, effect of prolonged single-housing, reduction in self-injurious behavior (SIB), macaques.

Reinhardt, V. and M. Garza Schmidt (2000). **Daily feeding enrichment for laboratory macaques: inexpensive options**. *Laboratory Primate Newsletter* 39(2): 8-11. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn39-2.html
NAL Call Number: SF407.P7 L3
Descriptors: foraging behavior, ceiling food puzzle, food puzzles, animal behavior, cost and labor savings, cage structure, *Macaca* sp.

Reinhardt, V. and A. Reinhardt (2001). ***Environmental Enrichment for Caged Rhesus Macaques: A Photographic Documentation and Literature Review***, 2nd edition, Animal Welfare Institute: Washington, DC, 77 p.
Online: http://www.awionline.org/lab%5Fanimals/rhesus/photo.htm
NAL Call Number: HV4737.R45 2001
Descriptors: primates as laboratory animals, rhesus macaques, *Macaca mulatta*, environmental enrichment techniques, photographs, housing and handling methods, social housing, wood sticks.

Rice, T.R., H. Harvey, R. Kayheart, and C. Torres (1999). **Effective strategy for evaluating tactile enrichment devices for singly caged macaques**. *Contemporary Topics in Laboratory Animal Science* 38(5): 24-26. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: Since the mandate for providing environmental enrichment for nonhuman primates was included in the Animal Welfare Act, numerous articles and suggestions have been put forth covering tactile devices and creative cage arrangements. For larger primate facilities and research programs environmental enrichment evaluation is usually accomplished by enrichment technicians or behaviorists. However, for the smaller facilities or programs, the ability to formulate and document an enrichment program can be very difficult due to budget or personnel constraints. We present a simple, yet effective, tactile device scoring system used with singly caged macaques indicating that creating and documenting enrichment ideas can be accomplished without a large personnel and budgetary commitment. We believe this strategy will help programs meet the regulatory requirements with relative ease.
Descriptors: enrichment devices, enrichment technicians, behaviorists, enrichment program development, tactile device scoring system, single housing, regulatory requirements, United States Animal Welfare Act, small facilities.

Roberts, S.J. and M.L. Platt (2005). **Effects of isosexual pair-housing on biomedical implants and study participation in male macaques.** *Contemporary Topics in Laboratory Animal Science* 44(5): 13-18. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: Social housing has been shown to contribute to the psychological well-being and physical health of captive primates, and this factor has led to United States Department of Agriculture guidelines requiring facilities to address the social needs of primate species known to

live socially in nature as long as doing so does not endanger the animals or interfere with research goals. Although pair-housing is the best way to provide social enrichment, many researchers and facilities are hesitant to implement it, particularly in biomedical research contexts where implanted devices or behavioral performance might be compromised. In order to study the effects of pair-housing on biomedical implants and study participation, we collected data from a group of isosexually pair-housed male macaques (adult and subadult) with 1) cranial and eye implants and 2) controlled access to water as means of motivating subjects to participate in psychophysical studies. Implants, study participation, and weight gain were not adversely affected by pair-housing. Our results support the use of pair-housing as social enrichment for macaques with biomedical implants and controlled access to water.
Descriptors: *Macaca mulatta*, *Macaca fascicularis*, primates as laboratory animals, male macaques, psychological well-being, group housing of primates with implanted devices, pair housing as social enrichment, controlled access to water, prostheses and implants, social behavior of primates in captivity, biomedical research environment, environmental enrichment, animal welfare, animal behavior.

Schapiro, S.J. (2002). **Effects of social manipulations and environmental enrichment on behavior and cell mediated immune responses in rhesus macaques**. *Pharmacology Biochemistry and Behavior* 73(1): 271-278. ISSN: 0091-3057.
NAL Call Number: QP901.P4
Abstract: This paper reviews a series of studies that have examined the effects of manipulations to the social and the inanimate environments on the behavior and cell-mediated immune responses of rhesus macaques of various ages living in different settings. In general, enrichment of the inanimate environment with toys, structures, foraging devices, and/or videotapes increased the amount of species-typical behavior expressed by the monkeys, but did not affect their immune responses. Housing monkeys socially, on the other hand, not only resulted in increased time spent in species-typical activities, but also resulted in (1) decreases in time spent in abnormal behavior and (2) changes in a number of immune parameters. Additionally, attempts to directly influence the affiliative interactions of socially housed adult rhesus have resulted in systematic changes in affiliative behavior, although anticipated accompanying systematic alterations to cell-mediated immune responses have yet to be realized. The data suggest that aspects of the physical and social environments influence behavioral and immunological parameters in captive macaques in the absence of other experimental manipulations. As such, these influences need to be appropriately managed and/or controlled in order to minimize potential confounds in experimental designs.
Descriptors: literature review, social environment, enriched housing, *Macaca mulatta*, foraging devices, animal behavior, toys, videotapes, immune responses, confounding aspects of experimental protocols.

Schapiro, S.J. and M. Bloomsmith (2001). **Lower-row caging in a two-tiered housing system does not affect the behaviour of young singly housed rhesus macaques**. *Animal Welfare* 10(4): 387-394. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Macaca mulatta*, primates in laboratory settings, young animals, single housing, effect of light and location on normal and abnormal behavior, light intensity, animal welfare.

Schapiro, S.J., P.N. Nehete, J.E. Perlman, and K.J. Sastry (2000). **A comparison of cell-mediated immune responses in rhesus macaques housed singly, in pairs, or in groups.** *Applied Animal Behaviour Science* 68(1): 67-84. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: *Macaca mulatta*, housing conditions in the laboratory, primates as laboratory animals, social enrichment, group size, cell-mediated immune responses, animal welfare.

Storey, P.L., P.V. Turner, and J.L. Tremblay (2000). **Environmental enrichment for rhesus macaques: A cost effective exercise cage.** *Contemporary Topics in Laboratory Animal Science* 39(1): 14-16. ISSN: 1060-0558.

NAL Call Number: SF405.5.A23
Abstract: Providing suitable and varied environmental enrichment opportunities for nonhuman primates is both challenging and expensive, requiring institutions to be innovative when planning an enrichment program. Equipment must be durable, nontoxic, easily sanitized and disinfected, and readily assembled or prepared by animal care personnel. We developed a portable exercise cage for singly housed macaques from pre-existing but outdated caging; our cage met the described requirements and was used in animal-holding rooms. Modifying existing caging for this purpose led to substantial cost savings. These cages have proved to be popular with animals and their affiliated research teams.
Descriptors: primates as laboratory animals, enriched environment, exercise, portable cage, cost considerations, single housing, *Macaca mulatta*.

Taylor, D.K., T. Bass, G.S. Flory, and F.C. Hankenson (2005). **Use of low-dose chlorpromazine in conjunction with environmental enrichment to eliminate self-injurious behavior in a rhesus macaque (*Macaca mulatta*)**. *Comparative Medicine* 55(3): 282-288. ISSN: 1532-0820.
NAL Call Number: SF77 .C65
Abstract: A 7-year-old, captive-bred, female rhesus macaque was placed in a quarantine facility upon arrival at our institution. At release from quarantine, she was observed pawing at and chewing on her left cheek. Physical examination revealed ulcerative lesions on the buccal surface of the left cheek. Initial differential diagnoses included Cercopithecine herpesvirus 1 (B virus)-induced lesions and bacterial infection. Dental abnormalities and cheek pouch foreign body were ruled out during the physical exam. Treatment with 30 mg/kg cefazolin intramuscularly every 12 h was initiated. Twelve days later, the animal presented with a 2 x 2-cm, full-thickness erosion involving the opposite (right) cheek. Treatment with buprenorphine (0.1 mg/kg intramuscularly every 24 h) was initiated. Cultures for B virus were negative, and only nonpathogenic bacteria were isolated from swabs of the lesions. Hematology and serum chemistry profiles were normal. A wedge biopsy of the lesion revealed no definitive etiology. Further observation revealed that the lesions likely resulted from self-injurious behavior (SIB). Treatment with low-dose chlorpromazine (1 mg/kg intramuscularly once daily for 25 days, and then 0.5 mg/kg intramuscularly once daily for 25 days) was initiated. Bodyweight and condition were maintained during therapy, and serial hematology and serum chemistry profiles were normal. The animal was moved into a different room, and a toy "necklace" was created. The SIB was eliminated, and lesions healed within 35 days. Presently, 20 months after presentation, this animal remains in good health.
Descriptors: self-injurious behavior (SIB), abnormal behavior treatment, primates as laboratory animals, environmental enrichment, chlorpromazine, location change, adult female rhesus macaque, *Macaca mulatta*, pawing and chewing at cheek, behavioral treatment program, toy necklace , case study.

Tsuchida, J., K. Kawasaki, T. Sankai, N. Kubo, K. Terao, T. Koyama, J. Makino, and Y. Yoshikawa (2003). **New type of puzzle-task finger maze learning in *Macaca fascicularis***. *International Journal of Primatology* 24(2): 261-270. ISSN: 0164-0291.
NAL Call Number: QL737.P9I54
Descriptors: cognitive abilities, cynomolgus macaques, *Macaca fascicularis*, puzzle feeders , noncorrection-type finger maze (4FM), task difficulty, training of animals.

Turner, P.V. and L.E.II. Grantham (2002). **Short term effects of an environmental enrichment program for adult cynomolgus monkeys**. *Contemporary Topics in Laboratory Animal Science* 41(5): 13-17. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: Behavior patterns (including behavior disorders) of cynomolgus monkeys are established early in life, and exploratory behavior lessens with age. Whether environmental enrichment programs benefit these animals can be questioned, particularly for animals housed short-term. We evaluated the overall effect of our environmental enrichment program in 40 newly arrived male and female adult cynomolgus monkeys to determine whether it impacted animal well-being. Animals allocated into two groups one that received environmental enrichment (the enriched group) and one that did not (the nonenriched, control group) and behaviors were

assessed over a 5-week period. We also examined the effect of enrichment on training time for a simple activity (entering a transfer box). Animals that had environmental enrichment made use of additional cage space, toys, and foraging items, but trends in observed in-cage behavior patterns were relatively unchanged throughout the course of the study. After study completion, physical evidence of self-trauma was found in 25% of the nonenriched animals but not in any of those in the enriched group. Enrichment had no notable effect on body weight or training time for a simple activity. Our findings suggest that provision of a comprehensive environmental enrichment program provides a beneficial effect to adult cynomolgus macaques singly housed short-term.
Descriptors: *Macaca fascicularis*, long-tailed macaques, primates as laboratory animals, environmental enrichment, animal welfare, group size, training of animals, abnormal behavior, self-injurious behavior (SIB), individual housing, effects of enriched versus non-enriched environments.

Vick, S.J., J.R. Anderson, and R. Young (2000). **Maracas for *Macaca*? Evaluation of three potential enrichment objects in two species of zoo housed macaques**. *Zoo Biology* 19(3): 181-191 . ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: *Macaca arctoides*, Barbary macaques, *Macaca sylvanus*, stump-tailed macaques, unresponsive objects, rattles, foraging devices, environmental enrichment, comparison study, effects of novelty, primates in zoo settings, species differences, manipulation of enrichment objects.

Washburn, D.A., J. Gulledge, and D. Rumbaugh (2001). **Long-term testing of macaques with the computerized test system: implications for cognition and enrichment**. *American Journal of Primatology* 54(Suppl. 1): 90-91. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Macaca mulatta*, rhesus macaques, joystick tasks, computerized testing systems, interest of monkeys in computerized tasks, comparative assessment of cognitive processes, meeting abstract.
Notes: 24th Annual Meeting of The American Society of Primatologists, Savannah, Georgia, USA; August 8-11, 2001.

Watson, L. (2003). **Pair- and singly-housed adult male *M. fascicularis*' behavioral response to varying video tape subject matter**. *American Journal of Primatology* 60 (Suppl. 1): 83. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: long-tailed macaques, *Macaca fascicularis*, behavioral study, nature film, cartoons, video preferences, effect of housing condition, aggression, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Alberta, Canada; July 29 - August 2, 2003.

Watson, L. (2002). **A successful program for same-and cross-age pair-housing adult and subadult male *Macaca fascicularis***. *Laboratory Primate Newsletter* 41(2): 6-9. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn41-2.html
NAL Call Number: SF407.P7 L3
Descriptors: long-tailed macaques, pair-housed males, process of socialization, psychological well-being, behavioral management program, behavioral observations.

Watson, S., R. Stavisky, and J. Kaplan (1999). **Exposure to novelty enhances problem-solving proficiency in cynomolgus macaques (*Macaca fascicularis*)**. *American Journal of Primatology* 49(1): 113. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: novel objects, brief exposure, open-field environment, puzzle-feeder task, neophobia, meeting abstract, long-tailed macaques.
Notes: 22nd Annual Meeting of the American Society of Primatologists, Tulane University, New Orleans, Louisiana, USA; August 12-16, 1999.

Watson, S.L., C.A. Shively, and M.L. Voytko (1999). **Can puzzle feeders be used as cognitive screening instruments? Differential performance of young and aged female monkeys on a puzzle feeder task**. *American Journal of Primatology* 49(2): 195-202. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Conventional cognitive testing of monkeys is time-consuming and involves single-caging and food or water deprivation. Here we report a novel test of global cognitive performance that can be completed in a short time period without food/water or social restrictions. Nine mazes of increasing difficulty were developed using a standard puzzle feeder, and the maze-solving performance of ten young and five aged female cynomolgus monkeys (*Macaca fascicularis*) was tested. The young monkeys solved maze configurations at higher levels of difficulty and solved the first level of difficulty more quickly than aged monkeys. This task discriminated performance by age in nonhuman primates as do more conventional forms of cognitive testing and indicates that this task may be a quick and easy assessment of global cognitive function.
Descriptors: long-tailed macaques, *Macaca fascicularis*, problem solving, juvenile and adult female monkeys, solving mazes of various difficulties, task discrimination, puzzle feeders.

Westergaard, G.C., M.K. Izard, and J.H. Drake (2000). **Reproductive performance of rhesus macaques (*Macaca Mulatta*) in two outdoor housing conditions**. *American Journal of Primatology* 50(1): 87-93. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: reproduction, high-density gang cages, low-density outdoor corrals, amount of space, social stress, housing system effects on birth rates, rhesus macaques.

Westergaard, G.C., M.K. Izard, J.H. Drake, S.J. Suomi, and J.D. Higley (1999). **Rhesus macaque (*Macaca mulatta*) group formation and housing: wounding and reproduction in a specific pathogen free (SPF) colony**. *American Journal of Primatology* 49(4): 339-347. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: In the present report, we examined the effects of group formation strategy and corral design on wounding and reproduction rates in rhesus macaques. Specifically, we examined group formation using a staged strategy, in which small groups of animals were introduced incrementally over a period of weeks, and a rapid formation strategy, in which all animals were introduced in 1 day. We also examined group formation using a divided corral design that facilitated visual and social separation of individuals, and an undivided corral design that did not facilitate visual or social separation. Dependent measures were wounding and reproductive rates over each of the 2 years that followed group formation. Results indicate that incrementally releasing subgroups of animals, and using a corral design that provides for visual and social separation of individuals, are effective strategies for reducing rates of traumatic wounding when forming multimale-multifemale rhesus macaque breeding groups. However, it must be noted that differences in formation strategy and corral design did not lead to higher reproductive rates. We conclude that incrementally releasing animals in hierarchical subgroups, and using a divided vs. undivided housing design, reduced intra-group wounding and associated demands on veterinary and animal management resources following formation of rhesus macaque breeding groups.
Descriptors: *Macaca mulatta*, rhesus macaques, social behavior, injury, housing environment, breeding groups, group formation using a staged or rapid approach, reduction of wounding during group formation, corral design, effects on reproductive rates.

Old World Monkeys

Barr, D. (2002). **Visiting the vervets: Cheap and easy enrichment**. *Animal Keepers' Forum* 29(9): 369-374. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: *Cercopithecus aethiops*, vervets, African green monkeys, care in captivity, interactions with zoo visitors as environmental enrichment.

Bassett, L. (2000). **The benefits of social enrichment for zoo-housed primates**. In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 53-62.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: mandrills, *Mandrillus sphinx*, animal welfare, wild animals in captivity, zoo settings, social housing, effects of group size on the behavior, activity budgets, enrichment by increasing group size, European Zoos.

Blois Heulin, C. and R. Jubin (2004). **Influence of the presence of seeds and litter on the behaviour of captive red-capped mangabeys *Cercocebus torquatus torquatus***. *Applied Animal Behaviour Science* 85(3-4): 349-362. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: *Cercocebus torquatus torquatus*, mangabeys, animal welfare, environmental enrichment, foraging behavior, time budgets, animal behavior, sex differences, bare ground, addition of seeds and litter to environment.

Bourgeois, S. and L. Brent (2003). **The effect of four enrichment conditions on abnormal behavior in seven singly caged baboons (*Papio hamadryas anubis*)**. *American Journal of Primatology* 60(Suppl. 1): 80-81. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Papio hamadryas anubis*, baboons, single housing, comparison study, effects of environmental enrichment, positive reinforcement training, food enrichment, non-food enrichment, social enrichment, self-directed behavior, caging, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Bourgeois, S.R. and L. Brent (2005). **Modifying the behaviour of singly caged baboons: Evaluating the effectiveness of four enrichment techniques**. *Animal Welfare* 14(1): 71-81. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: adolescent male olive hybrid baboons, *Papio hamadryas anubis*, abnormal behavior, effectiveness of enrichment techniques to reduce abnormal behavior, positive reinforcement training, food enrichment, manipulable toys and objects, social environment, activity levels, animal welfare implications, social enrichment as a means of behavior modification for captive baboons.

Chang, T.R., D.L. Forthman, and T.L. Maple (1999). **Comparison of confined mandrill (*Mandrillus sphinx*) behavior in traditional and "ecologically representative" exhibits**. *Zoo Biology* 18(3): 163-176. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: *Mandrillus sphinx*, mandrills, exhibit design, foraging, social behavior, cages, physical activity, animal welfare, environmental enrichment, species-appropriate behavior.

Crockett, C.M. and G.M. Gough (2002). **Onset of aggressive toy biting by a laboratory baboon**

coincides with cessation of self-injurious behavior. *American Journal of Primatology* 57(Suppl. 1): 39. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: self-injurious behavior (SIB), *Papio cynocephalus anubis*, baboons, animals on a bone marrow transplant protocol, biting of toys, re-direction of tension-related aggression, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologist, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Davey, G. (2005). **An environmental design project at Beijing Zoo**. *International Zoo News* 52(2): 80-88; No 339. ISSN: 0020-9155.
NAL Call Number: QL76.I58
Descriptors: *Mandrillus sphinx*, mandrills, primates in captivity, zoo project report, animal housing in zoos, environmental enrichment techniques, Beijing, China, Beijing Zoo.

Grams, K. and J. Roletto (2002). **Genus-specific foraging unit deters destructive behavior in the mandrill (*Mandrillus sphinx*)**. *Animal Keepers' Forum* 29(1): 30-31. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: *Mandrillus sphinx*, mandrills, feeding enrichment, effect of environmental enrichment on destructive behavior in captive primates, foraging behavior.

Harris, H. and A. Edwards (2004). **Mirrors as environmental enrichment for African green monkeys**. *American Journal of Primatology* 64(4): 459-467. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Stainless steel circular mirrors were employed in an enrichment plan for 105 singly housed male African green monkeys. We observed 25 randomly selected males to measure mirror use and to assess the mirrors' effectiveness as an enrichment item. We conducted additional mirror-use surveys on all 105 males using fingerprint accumulation as an indicator (rated on a scale of 0 to 4). Use was defined as either being in contact with the mirror (contact use (CU)) or looking directly into the mirror without contact (non-contact use (NC)). Mirror-use data were collected 10 months after the initial introduction of the mirrors and again at 16 months. The two time points were compared by paired t-tests. No significant difference in use was found between the two data collection points. On average, the monkeys used the mirrors 5.2% of the total time intervals recorded (approximately 3 min/hr). Results from the five fingerprint-accumulation surveys showed that 102 of 105 males (97%) had CU with their mirrors over the survey points. Based on the sustained use of the mirrors over a 6-month period, we concluded that the mirrors were an effective enrichment tool that the vast majority of our monkeys routinely used. Habituation did not appear to occur even a year after the mirrors were introduced.
Descriptors: *Cercopithecus aethiops*, vervets, African green monkeys, single housed males, fingerprint accumulation as indicator of usage, usage survey, time spent using stainless steel mirrors.

Hartley, D. (2003). **Space-use by a captive group of juvenile olive baboons (*Papio hamadryas anubis*)** . *American Journal of Primatology* 60 (Suppl. 1): 81. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Papio hamadryas anubis*, juvenile baboons, use of cage space, PVC perch, animal behavior, scan sampling, dominance hierarchy, relative cage size, environmental enrichment, meeting abstract.
Notes: 26th Annual Meeting of the American Society of Primatologists, Calgary, Alberta, Canada; July 29-August 2, 2003.

Hienz, R.D., D.A. Pyle, J.J. Frey, T.J. Zarcone, R.J. Adams, and J.S. Turkkan (2000). **Enrichment device use by baboons during long-term vs. intermittent availability**. *Laboratory Primate Newsletter* 39(2): 1-4. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn39-2.html
NAL Call Number: SF407.P7 L3

Descriptors: baboons, activity monitoring devices, environmental enrichment, availability of enrichment, cherry logs, animal behavior, habituation, activity patterns, frequency of use of enrichment devices.

Jones, M. and N. Pillay (2004). **Foraging in captive hamadryas baboons: implications for enrichment**. *Applied Animal Behaviour Science* 88(1-2): 101-110. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: *Papio hamadryas hamadryas*, captive baboons, foraging behavior, aggression, food enrichment devices, environmental enrichment, zoos.

Jones, P., D. Pazzaglia, and B. Richards (2002). **Using enrichment as a management tool**. *Animal Keepers' Forum* 29(4): 166-169. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: *Mandrillus sphinx*, mandrills, care in captivity, enrichment program management.

Jubin, R., B.L. Deputte, and H.C. Blois (2001). **Evaluation of the effect of two kinds of screens, installed in their cage, on the social behaviour of a group of red-capped mangabeys (*Cercocebus torquatus*)**. *Folia Primatologica* 72(3): 121-122. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: *Cercocebus torquatus*, mangabeys, visual block, mesh screen and opaque screen comparison study, environmental enrichment, effects on social behavior, meeting abstract.
Notes: 12th Annual Meeting of La Societe Francophone de Primatologie, Besancon, France; September 27-29, 2000.

Kessel, A. and L. Brent (2001). **The rehabilitation of captive baboons**. *Journal of Medical Primatology* 30(2): 71-80. ISSN: 0047-2565.
NAL Call Number: QL737.P9J66
Abstract: Eleven baboons who had been singly housed indoors for an average of 5 years were moved to outdoor social groups in an attempt to provide a more species-typical environment and reduce high levels of abnormal behavior. Nine of the baboons were observed while in single housing and, over a 6-month period, while housed outdoors socially to document long-term changes in behavior. Abnormal behavior decreased significantly from an average of 14% of the observation time in the single cages to 3% in the sixth month of social housing. Cage manipulation and self-directed behaviors also significantly decreased, while social behavior, enrichment-directed behavior, and locomotion increased in social housing. Baboons that had been in long-term indoor single housing were able to reproduce and form stable social groups without injury. This study provides evidence that even behaviorally disturbed nonhuman primates can be successfully rehabilitated to live in social groups.
Descriptors: captive baboons, species-typical behaviors, abnormal behavior, baboons, single housing to outdoor social housing, animal behavior, cage manipulation, behavioral rehabilitation.

Little, K.A. and V. Sommer (2002). **Change of enclosure in langur monkeys: Implications for the evaluation of environmental enrichment**. *Zoo Biology* 21(6): 549-559 . ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: langurs, zoo animals, group housing, animal space requirements, physical activity, grooming behavior, attachment behavior, aggression, animal stress, animal well-being, effects of a multi-species enclosure.

Maetz Rensing, K., A. Floto, and F.J. Kaup (2004). **Intraperitoneal foreign body disease in a baboon (*Papio hamadryas*)**. *Journal of Medical Primatology* 33(2): 113-116. ISSN: 0047-2565.
NAL Call Number: QL737.P9J66
Descriptors: Hamadryas baboon, *Papio hamadryas*, intraperitoneal foreign body, clinico-pathological description, case study, risk of items used for environmental enrichment.

Marks, D., J. Kelly, T. Rice, S. Ames, R. Marr, J. Westfall, J. Lloyd, and C. Torres (2000). **Utilizing restraint chair training to prepare primates for social housing**. *Laboratory Primate Newsletter*

39(4): 9. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn39-4.html
NAL Call Number: SF407.P7 L3
Descriptors: *Papio hamadryas hamadryas*, baboons, pole and collar training, behavioral management, juvenile hamadryas baboons, enrichment program, stress, socialization.

Mikels, J. and J. Wallis (2003). **Effects of cage mounted enrichment on behavior of a group of juvenile baboons (*Papio anubis*).** *American Journal of Primatology* 60 (Suppl. 1): 81-82. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: *Papio anubis*, female baboons, children's toys mounted on cages, young animals, animal behavior, social housing, decreased aggression and grooming when enrichment is present, meeting abstract.

Seier, J.V., M.A. Dhansay, and A. Davids (2005). **Risks associated with environmental enrichment: Intestinal obstruction caused by foraging substrate.** *Journal of Medical Primatology* 34(3): 154-155. ISSN: 0047-2565.
NAL Call Number: QL737.P9J66
Abstract: Questions are occasionally asked about the safety of enrichment techniques, considering that many novel ways are frequently employed to ensure environmental complexity. A juvenile male vervet monkey was found with a phytobezoar of straw obstructing the sigmoid colon. The straw was foraging substrate, which is used in communal cages. Due to the extent of the resulting necrosis in the sigmoid and descending colon, the monkey had to be killed. This is the only individual to have suffered a harmful effect from the foraging substrate from amongst 120 vervet monkeys, which have been permanently housed on straw for over 5 years.
Descriptors: *Cercopithecus aethiops*, intestinal obstruction, environment enrichment, fatal outcome, risks associated with enrichment, straw, foraging substrate, vervet monkey, euthanasia, case report.

Stahl, D. and W. Kaumanns (2003). **Food competition in captive female sooty mangabeys (*Cercocebus torquatus atys*).** *Primates* 44(3): 203-216. ISSN: 0032-8332.
Abstract: We studied the social and foraging behavior of two captive groups of sooty mangabeys under two different spatial food situations. These food conditions were clumped (food was placed in a box) and dispersed (food was dispersed over the entire enclosure). In each group five adult females and two adult males were observed. As a criterion for food competition, individual differences in the relative food intake were used. Adult female mangabeys had a linear, stable, and unidirectional dominance hierarchy. Access to food was rank dependent among females only under clumped food distribution, as current models of the evolution of primate social systems predict. However, feeding success appeared to be mediated not by female but by male agonistic behavior toward females. High-ranking females received relatively less aggression from males and could, therefore, stay and feed longer in the feeding area. Male tolerance of higher-ranking females seems to mediate female feeding success under restricted food resources. The establishment of a special relationship with a high-ranking male might, therefore, be a strategy to get better access to food. This study demonstrates that female competition for access to food should not be analyzed separately from male influences on females and suggests that a more integral role of males in socioecological models of the evolution of primate social systems should be considered.
Descriptors: *Cercocebus torquatus atys*, mangabeys, gender effects, males and females, feeding behavior, food deprivation, social behavior, social dominance.

Tami, T. and S. Diverio (2000). **Effects of environmental enrichment on the behaviour of white crowned mangabeys (*Cercocebus torquatus lunulatus*)** . *Advances in Ethology* (35): 28. ISSN: 0931-4202.
Descriptors: *Cercocebus torquatus lunulatus*, mangabeys, species-typical behavior, cage space utilization, environmental enrichment, social behavior, meeting abstract.

Wallis, J. (2002). **Reproduction in baboons: The influence of environmental enhancement**. *American Journal of Primatology* 57(Suppl. 1): 85. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: baboons, climbing structures, effects of environmental complexity, gestation period, group size, housing, meeting abstract, social behavior.

Marmosets and Tamarins

Boon, M. (2003). **Goeldi's monkeys (*Callimico goeldii*): Olfactory enrichment to stimulate natural behaviour and greater activity**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, England, p. 212-224.
Descriptors: *Callimico goeldii*, Goeldi's monkey, olfactory enrichment, chemoreception, activity patterns, feces, peppermint oil, predator recognition, Marwell Zoo, UK.

Buchanan-Smith, H.M., C. Shand, and K. Morris (2002). **Cage use and feeding height preferences of captive common marmosets (*Callithrix j. jacchus*) in two-tier cages**. *Journal of Applied Animal Welfare Science* 5(2): 139-149. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Determining appropriate feeding regimes has important welfare implications for captive primates. This study examined the preference of food bowl heights in 6 pairs of common marmosets (*Callithrix jacchus*) housed in a 2-tier cage system. Given that marmosets are arboreal and spend most of their time in the upper half of their cages, we predicted that the marmosets would prefer a food bowl positioned at the top of the cage over one positioned at the bottom. We further predicted that this would be more apparent for the marmosets housed in lower tier than upper tier cages. Given a choice regarding where to feed, marmosets did prefer the top bowl to the bottom bowl; how-ever, when only 1 food bowl was presented, its position had no significant effect on the marmosets' feeding behavior. In addition, contrary to the prediction, there were few differences in the marmosets' feeding behavior in the upper and lower tier cages. Feeding the marmosets in a bowl at the bottom of their cage did not result in greater cage use. On the basis of this study, we recommend positioning captive marmosets' food bowls high in the cage.
Descriptors: *Callithrix j. jacchus*, marmosets, food bowl height preference study, feeding behavior and location of food containers, animal welfare, facility design and construction, time factors.

Byron, J.K. and M.S. Bodri (2001). **Environmental enrichment for laboratory marmosets**. *Lab Animal* 30(8): 42-48. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: The authors report on using two environmental enrichment devices for marmosets, and suggest the design of five other devices that may be more successful in stimulating foraging or grooming behavior than the devices tested.
Descriptors: animal welfare, foraging behavior devices, grooming behavior, environmental enrichment in the laboratory, animal housing, *Callithrix sp.*, marmosets.

Byron, J.K. and M.S. Bodri (2001). **Resource environmental enrichment for laboratory marmosets**. *Lab Animal* 30(8): 42-49. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Descriptors: animal welfare, marmosets as laboratory animals, *Callithrix sp.*, exploratory behavior, feeding behavior, grooming, housing, play and playthings, toys.

Chamove, A.S. (2005). **Environmental enrichment for monkeys using plants**. *Laboratory Primate Newsletter* 44(2): 1-5. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn44-2.html
Descriptors: live plants as protective cover in animal exhibits, cotton-top tamarins, *Saguinus oedipus oedipus*, family group housing, primates as laboratory animals, species-typical behavior, naturalistic exhibits, change in animal behavior after addition of plants to enclosure, addition of vertical mesh to enclosure for climbing, growing plants, plant maintenance costs.

Chamove, A.S. and L. Scott (2005). **Forage box as enrichment in single- and group-housed**

Callitrichid monkeys. *Laboratory Primate Newsletter* 44(2): 13-17. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn44-2.html
Descriptors: common marmosets, *Callithrix jacchus*, cotton-top tamarins, *Saguinus oedipus*, motivation for foraging, forage box tax, food preferences, comparison of single housing versus group housing on completion of task, promotion of species-typical behavior, primates as laboratory animals.

de Rosa, C., A. Vitale, and M. Puopolo (2003). **The puzzle feeder as feeding enrichment for common marmosets (*Callithrix jacchus*): A pilot study**. *Laboratory Animals* 37(2): 100-107. ISSN: 0023-6772.
NAL Call Number: QL55.A1L3
Abstract: The use of a puzzle-feeder, as feeding enrichment, was investigated in three families of captive common marmosets (*Callithrix jacchus*). The study was carried out as a simultaneous choice test between two cages: one contained the puzzle-feeder, the other contained the usual food dishes, but otherwise both were arranged similarly. The monkeys were allowed to choose whether to feed from the usual dishes, or from the puzzle-feeder which required more effort. They were observed for two sessions in which they were differently motivated to feed. The enriched cage was always visited first, the marmosets managed to extract food from the puzzle-feeder, and spent more time eating from the puzzle-feeder when less hungry. These data contribute to a wider understanding on the use, and the effects, of feeding enrichments with different captive non-human primates.
Descriptors: animal welfare, *Callithrix jacchus*, marmosets, choice test, controlled environment, feeding behavior, problem solving, puzzle feeders.

de Rosa, C., A. Vitale, and M. Puopolo (2001). **Puzzle-feeders as environmental enrichment in common marmosets (*Callithrix jacchus*)**. *Folia Primatologica* 72(3): 131. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: *Callithrix jacchus*, marmosets, puzzle feeders as enrichment devices, preference tests, provision of choice, food-related behavior, age composition of social groups, meeting abstract.
Notes: 14th Meeting of the Italian Primatological Society, Pisa-Calci, Italy; October 9-11, 2000.

de Vleeschouwer, K., K. Leus, and L. van Elsacker (2003). **Stability of breeding and non-breeding groups of golden-headed lion tamarins (*Leontopithecus chrysomelas*)**. *Animal Welfare* 12(2): 251-268. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Leontopithecus chrysomelas*, golden-headed lion tamarins in zoos, group size, aggression, population structure, contraception, age structure of groups, female fertility, sex ratio, parturition interval, effects of animal behavior on husbandry.

Farmerie, M. (2004). **Evolving a Callitrichid behavioral husbandry program into an innovative educational partnership - completing the circle: Callitrichid biology, conservation and captivity**. In: *Animal Behavior Management Alliance (ABMA) Conference Proceedings 2004, April 4-9, 2004, Baltimore, Maryland, USA,* Animal Behavior Management Alliance: p. 82-85. [CD-Rom]
Descriptors: cotton-top tamarins, Callitrichid, natural history, conservation, captive management, educational programs, operant conditioning, training game.

Gaspari, F., G. Perretta, and G. Schino (2000). **Effects of different housing systems on the behaviour of the common marmoset (*Callithrix jacchus*)**. *Folia Primatologica* 71(4): 291. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: housing conditions, environmental enrichment, animal behavior, well-being evaluation, family groups, cage size, cage furniture, effects on play and exploration, *Callithrix jacchus*, marmosets, meeting abstract.
Notes: 13th Meeting of the Italian Primatological Society, Pavia, Italy; September 17-19, 1998.

Gerber, P., C.R. Schnell, and G. Anzenberger (2002). **Behavioral and cardiophysiological responses of common marmosets (*Callithrix jacchus*) to social and environmental changes**. *Primates* 43(3): 201-216. ISSN: 0032-8332.
Abstract: Under captive conditions common marmosets (*Callithrix jacchus*) show socially monogamous propensities. Male and female form a social bond as characterized by signs of behavioral arousal during separation of the pairmates, high levels of affiliative interactions between pairmates and agonistic responses towards strange conspecifics. In the present study behavioral and cardiophysiological responses of mated individuals of common marmosets were recorded while the animals were in an unfamiliar environment (1) alone, (2) with the pairmate, or (3) with an opposite-sexed stranger. Pairmates of 6 established pairs were tested in 3 replicates yielding a total of 36 trials per experiment. A trial was divided into three 10-min segments (baseline; unfamiliar environment; reunion). Behavioral responses were videotaped with a remote controlled camera system installed within the cage. Systolic (SBP) and diastolic blood pressure (DBP), and heart rate (HR) as well as locomotor activity (ACT) were recorded telemetrically through peritoneally implanted transmitters. The individuals' responses measured while in an unfamiliar environment was only reduced by the pairmate, but not by an opposite-sexed stranger. No affiliative behaviors occurred between strange conspecifics, whereas aggressive and sexual behaviors were observed. During reunion with the pairmate individuals recovered physiologically. The present study shows that an individualized pair bond exists between pairmates of common marmosets. Further, it becomes evident that establishing a social bond with the pairmate is important for maintaining physiological homeostasis.
Descriptors: *Callithrix jacchus*, housing of captive marmosets, social behavior, psychological stress, zoo animals, effect of environment on heart rate and blood pressure, importance of social bonds, locomotion.

Gibbs, A. (2003). **Enrichment timetable for Goeldi's monkeys (*Callimico goeldii*) at Paignton Zoo Environmental Park.** In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, England, p. 4-8.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: *Callimico goeldii*, Goeldi's monkey, provision of enrichment devices, environmental complexity, timetable, food oriented devices, non-food enrichment, activity levels, Paignton Zoo Environmental Park, UK.

Hardie, S.M. and H.M. Buchanan Smith (2000). **Responses of captive single- and mixed-species groups of *Saguinus* to novel nonthreatening objects**. *International Journal of Primatology* 21(4): 629-648. ISSN: 0164-0291.
NAL Call Number: QL737.P9I54
Descriptors: novel objects, mixed-species groups, tamarins, behavioral responses to objects, natural conditions, placement of objects in enclosures, foraging behavior.

Hardy, A., C.P. Windle, H.F. Baker, and R.M. Ridley (2004). **Assessment of preference for grid flooring and sawdust flooring by captive bred marmosets in free standing cages**. *Applied Animal Behaviour Science* 85(1-2): 167-172. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: marmosets, *Callithrix jacchus*, comparison of grid and sawdust flooring in cages, environmental enrichment, video recording, behavioral needs, free standing cages, preference study.

Herron, S., E. Price, and D. Wormell (2001). **Feeding gum arabic to New World monkeys: Species differences and palatability.** *Animal Welfare* 10(3): 249-256 . ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: zoos, environmental enrichment, feeding enrichment, feed gum arabic, animal welfare, species comparison study.

Hosey, G.R., M. Jacques, and M. Burton (1999). **Allowing captive marmosets to choose the size and**

position of their nest box. *Animal Welfare* 8(3): 281-285. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Callithrix jacchus*, marmosets, provision of choice, nests size and location, wood and steel cage materials, discrimination study, importance of nest box height and position.

Jackson, M.J. (2001). **Environmental enrichment and husbandry of the MPTP treated common marmoset**. *Animal Technology* 52(1): 21-28 . ISSN: 0264-4754.
NAL Call Number: QL55.I5
Descriptors: *Callithrix jacchus*, marmosets as laboratory animals, animal models for Parkinson's disease, neurotoxins, animal husbandry, animal welfare, body weight, group size.

Majolo, B., H.M. Buchanan Smith, and J. Bell (2003). **Response to novel objects and foraging tasks by common marmoset (*Callithrix jacchus*) female pairs**. *Lab Animal* 32(3): 32-38. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Abstract: The authors analyze the effects of enrichment devices on the behavior of common marmoset female pairs, and determine which aspects of these devices are more likely to elicit explorative behaviors, and how their presence affects aggressive and stress-related behaviors. The results support the use of enrichment devices for captive primates and show that in marmosets, their effectiveness strongly depends on location within the enclosure and the presence of hidden food.
Descriptors: animal welfare, pair housed female marmosets, *Callithrix jacchus*, effects of environmental enrichment on behavior, feeding behavior , stress, decreased aggression.

Majolo, B., H.M. Buchanan Smith, and K. Morris (2003). **Factors affecting the successful pairing of unfamiliar common marmoset (*Callithrix jacchus*) females: Preliminary results**. *Animal Welfare* 12(3): 327-337. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Callithrix jacchus*, female marmosets, group housing laboratory primates, sexual maturity, aggression, fighting, grooming animal behavior, successful pair housing.

Manciocco, A. and M.V.A. Puopolo (2004). **Animal welfare and enrichment: A preference study in the common marmoset (*Callithrix jacchus*)**. *Folia Primatologica* 75(6): 393-394. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: *Callithrix jacchus*, common marmosets, environmental enrichment, animal welfare, preference studies, foraging behavior.
Notes: 16th Meeting of the Italian Primatological Society, Radicondoli, Siena, Italy; October 28-30, 2003.

McDermott, F.A.P. and T.E. Smith. (2003). **Operant conditioning can be used to train common marmosets (*Callithrix jacchus*) to scent-mark on demand**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park, Winchester, UK*, The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 20.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: common marmosets, *Callithrix jacchus*, training for natural behaviors, scent-marking, positive reinforcement, age and sex differences, six different social groups, meeting abstract.

McKinley, J. and H.M. Buchanan-Smith. (2003). **Improving the animal-human relationship with laboratory-housed common marmosets (*Callithrix jacchus*): Increased interactions and positive reinforcement training**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park, Winchester, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 27-37.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: operant conditioning, common marmosets, *Callithrix jacchus*, pair housed animals, laboratory research settings, animal-human relationships, decrease in stress-related behaviors,

positive reinforcement training, no change in aggression.

Norcross, J.L. and J.D. Newman (1999). **Effects of separation and novelty on distress vocalizations and cortisol in the common marmoset (*Callithrix jacchus*)**. *American Journal of Primatology* 47(3): 209-222. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: In socially-bonding species, separation from familiar attachment figures is widely known to stimulate a physiological and behavioral stress response. This study investigated the hormonal and vocal responses of adult common marmosets to separation from familiar group members and to 24 hr of cohabitation with an unfamiliar opposite-sex conspecific. All subjects were removed from their home cages and placed into a novel environment for 20 min. In one group, marmosets were exposed to an unfamiliar, opposite-sex partner in the novel environment and remained paired with this partner for the 24 hr test period. In three other groups, marmosets experienced the novel environment alone and subsequently were returned to their original social- or single-housing condition, or kept separate from their social groups for a 24 h period. Blood samples were collected the day before, and at 30 min, 90 min, and at 24 h after separation. Cortisol responses were differentially affected by the length of separation and the presence of unfamiliar conspecifics. Brief separation followed by the return to the social group had minimal effect on plasma cortisol levels. All marmosets produced high levels of separation calls in the novel environment, but there was no apparent relationship between calling and cortisol levels. The lack of a temporal relationship between the production of distress vocalizations and serum cortisol has previously been noted in squirrel monkey and rhesus monkey infant separation studies; the behavioral and physiological responses to separation appear to be similarly dissociated in the marmoset. Further, the characteristics of a separation environment can differentially affect the hormonal response by adult marmosets without differentially affecting their behavioral response.
Descriptors: *Callithrix jacchus*, adult marmosets, effects of separation and novel environments on hormones, social behavior, psychological stress, vocalization, hydrocortisone levels in blood.

Pines, M.K., G. Kaplan, and L.J. Rogers (2004). **Stressors of common marmosets (*Callithrix jacchus*) in the captive environment: Effects on behaviour and cortisol levels**. *Folia Primatologica* 75(Suppl. 1): 317-318. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Abstract: Salivary cortisol samples, collected using a cotton bud with banana on the tip, doubled following 30 minutes of exposure to playing radio (70-80 dB) or loud construction work (70-80 dB). Activity levels and time spent on the floor of the cage decreases, but there was no change in other stress-indicative behaviours.
Descriptors: *Callithrix jacchus*, marmosets, loud noises as stress factors, cortisol levels, stress induced behavior, captive environment.

Pines, M.K., G. Kaplan, and L.J. Rogers (2005). **Use of horizontal and vertical climbing structures by captive common marmosets (*Callithrix jacchus*)**. *Applied Animal Behaviour Science* 91(3-4): 311-319. ISSN: 0168-1591.
NAL Call Number: QL750.A6
Descriptors: physical activity, gender differences, cage design, environmental enrichment, animal preferences, marmosets, *Callithrix jacchus*, primates in captivity.

Prescott, M.J. and H.M. Buchanan Smith (2004). **Cage sizes for tamarins in the laboratory**. *Animal Welfare* 13(2): 151-158. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: captive animals, body size, use of cage area, species-specific behavior, aggression, *Callithrix jacchus*, *Saguinus labiatus*, *Saguinus oedipus*.

Queyras, A., R. Bernarducci, and A. Vitale (2001). **Arricchimento ambientale e separazione nello uistiti comune (*Callithrix jacchus*) in cattivita: As petti comportamentali e fisiologici. [Environmental enrichment during separation in captive common marmosets (*Callithrix***

jacchus): **Behavioural and physiological aspects]**. *Folia Primatologica* 72(3): 151-152. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: *Callithrix jacchus*, marmosets, environmental enrichment, behavioral responses, physiological responses, separation from social group, social effects on use of enrichment, puzzle feeders, competition, meeting abstract.
Language of Text: Italian; Summary in English.
Notes: 14th Meeting of the Italian Primatological Society, Pisa-Calci, Italy; October 9-11, 2000.

Renner, M.J., A.J. Feiner, M.G. Orr, and B.A. Delaney (2000). **Environmental enrichment for New World primates: Introducing food, irrelevant objects, and direct and secondary effects**. *Journal of Applied Animal Welfare Science* 3(1): 23-32 . ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: New World monkeys, zoo animals, enrichment, animal behavior, toys, cages , stimuli, animal welfare, *Callithrix geoffroyi*, *Cebuella pygmawa*, *Saguinus labiatus*, *Leontopithecus chrysomelas*.

Roberts, R.L., L.A. Roytburd, and J.D. Newman (1999). **Puzzle feeders and gum feeders as environmental enrichment for common marmosets**. *Contemporary Topics in Laboratory Animal Science* 38(5): 27-31. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: Common marmosets (*Callithrix jacchus jacchus*) are highly social New World monkeys that consume a principally gummivorous and insectivorous diet. We examined the efficacy of two types of foraging devices, Puzzle-Feeders(tm) and gum feeders, as environmental enrichment for marmosets housed singly (n = 16) or in sibling (n = 4) and heterosexual (n = 8) pairs. In experiment 1, marmosets were exposed to each of the two types of foraging devices for three hours, once per week for two weeks. Thirty-minute observations were conducted at the beginning and end of each exposure period. Marmosets in all housing conditions experienced significant reductions in the frequency of stereotyped pacing and significantly less time sitting still while exposed to the foraging devices. Marmosets experienced significantly lower levels of feeder use and significantly more time sitting still at the end of the three-hour exposure than at the beginning. Marmosets that were singly or sibling housed used the devices the most and had the largest reductions in time spent sitting still during enrichment. In experiment 2, singly housed marmosets were given two types of gum feeders, a wooden and a Gumabone(tm) gum feeder, each for a week-long period. Thirty-minute observations were conducted three times per week immediately after loading the feeders with fresh gum. The wooden gum feeders were heavily gouged during the week-long exposure, although significantly less use of both types of gum feeders was observed on the third and fifth days. These results indicated that marmosets in variable social housing conditions can benefit from environmental enrichment additional to social housing, and that foraging enrichment promotes increased non-stereotyped movement and decreased pacing in this species.
Descriptors: *Callithrix jacchus*, marmosets, foraging devices, housing conditions, behavioral data collection, gum and puzzle feeders, stereotypic behavior reduction.

Tardif, S.D., D.A. Smucny, D.H. Abbott, K. Mansfield, N. Schultz Darken, and M.E. Yamamoto (2003). **Reproduction in captive common marmosets (*Callithrix jacchus*)**. *Comparative Medicine* 53(4): 364-368. ISSN: 1532-0820.
NAL Call Number: SF77.C65
Abstract: Though sexual maturation may begin at around one year of age, first successful reproduction of the common marmoset (*Callithrix jacchus*) is likely to be later, and it is generally recommended that animals not be mated before 1.5 years of age. The average gestation period is estimated to be 143 to 144 days. A crown-rump length measurement taken by use of ultrasonography during the linear, rapid, prenatal growth phase (between approx. days 60 and 95) can be compared against standard growth curves to estimate delivery date to within 3 to 4 days, on average. Marmosets produce more young per delivery than does any other anthropoid primate, and have more variation in litter size. Many long-established colonies report that triplets

are the most common litter size, and there is documented association between higher maternal body weight and higher ovulation numbers. Higher litter sizes generally do not generate higher numbers of viable young. Marmosets are unusual among primates in having a postpartum ovulation that typically results in conception and successful delivery; reported median inter-birth intervals range from 154 to 162 days. However, pregnancy losses are quite common; one study of a large breeding colony indicated 50 percent loss between conception and term delivery. The average life span for breeding females is around six years; the range of reported average lifetime number of litters for a breeding pair is 3.45 to 4.0. Our purpose is to provide an overview of reproduction in the common marmoset, including basic reproductive life history, lactation and weaning, social housing requirements, and common problems encountered in the captive breeding of this species. A brief comparison between marmoset and tamarin reproduction also will be provided.
Descriptors: *Callithrix jacchus*, marmosets, importance of social housing for reproduction, optimal breeding age, gestation period, litter size, growth rate, laboratory animals, lactation, sexual maturity, comparison between marmoset and tamarin reproduction.

Ventura, R. and H.M. Buchanan Smith (2003). **Physical environmental effects on infant care and development in captive *Callithrix jacchus***. *International Journal of Primatology* 24(2): 399-413. ISSN: 0164-0291.
NAL Call Number: QL737.P9I54
Descriptors: *Callithrix jacchus*, environmental enrichment, common marmosets, social behavior, infant care, rate of development, play and exploration, motor skills, coping ability, laboratory environment, animal welfare.

Vignes, S., J.D. Newman, and R.L. Roberts (2001). **Mealworm feeders as environmental enrichment for common marmosets**. *Contemporary Topics in Laboratory Animal Science* 40(3): 26-29. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: The impact of a foraging enrichment device, the "mealworm feeder," on the behavior of the common marmoset was examined. In 3-h weekly exposures to the wormfeeder device, behavioral observations were conducted to compare the rates of feeder use, use of other enrichment devices, stereotyped behavior, and inactivity, to those of control sessions in which the enrichment device was not provided. Significantly decreased rates of pacing and time spent sitting still were observed in association with placement of the mealworm feeder. Feeder use declined over a period of 3 h, even if the feeders' contents were not fully depleted, and the effects of enrichment on activity waned in a like fashion. Use of other enrichment devices, comprised primarily of cage furniture, increased in the presence of the mealworm feeder. This effect did not change significantly over the 3 h of exposure even though use of the feeder declined. There was significant variation in feeder use among sex and housing condition, with females housed singly and in peer groups using the feeders significantly more than did males, whereas subadults used the feeder significantly more often than did either the dominant female or male in family groups. The results of this study suggest that the mealworm feeder is an effective form of environmental enrichment for the common marmoset, but interest wanes after approximately 3 hours.
Descriptors: common marmosets, *Callithrix jacchus*, environmental enrichment, feeding behavior, housing of animals, enrichment devices, mealworm feeders, sex differences, time of use.

Vitale A. and Licata E. (2004). **Refinement techniques in experimental protocols involving Callitrichids**. *Annali Dell'Istituto Superiore Di Sanita* 40(2): 237-240. ISSN: 0021-2571.
NAL Call Number: R65 .I8
Abstract: The invasiveness of biomedical experiments on laboratory animals should be limited to the greatest extent possible yet without sacrificing the quality of the data collected. To this end, refinement techniques can be used. In the present work, we describe some of these techniques, focussing on the familiarity of the experimental environment, alternative sampling techniques (including the use of positive training), telemetry, and methods for improving ethological experiments. As a model, we have chosen the common marmoset (*Callithrix jacchus*), which is

frequently used in biomedical research.
Descriptors: refinement techniques, nonhuman primates as research models, positive reinforcement training, telemetry, animal welfare, marmosets, *Callithrix jacchus*.
Language of Text: English; Summary in English, Italian.

Vitale, A. and A. Manciocco (2004). **Environmental enrichment techniques in non-human primates: The case of callitrichids**. *Annali Dell'Istituto Superiore Di Sanita* 40(2): 181-186. ISSN: 0021-2571.
Online: http://www.iss.it/publ/anna/2004/2/402181.pdf
NAL Call Number: R65 .I8
Abstract: In this paper, we discuss issues concerning the welfare of non-human primates used in laboratory research from an eco-ethological standpoint and suggest means of improving welfare. Following a brief review of the use of non-human primates in European countries and of the legislation that governs this use, we illustrate how a thorough eco-ethological knowledge of the species being studied can play a vital role in improving both its conditions and the quality of the experimental protocols, arguing that the animal's quality of life is closely linked to the quality of data. As a model for describing environmental enrichment techniques, we have used the common marmoset (*Callithrix jacchus*).
Descriptors: animal welfare, understanding species natural histories, environmental enrichment description, European legislation, nonhuman primates as laboratory animals, *Callithrix jacchus*.
Language of Text: English; Summary in English, Italian.

Voekl, B., E. Huber, and E. Dungl (2001). **Behavioral enrichment for marmosets by a novel food dispenser**. *Laboratory Primate Newsletter* 40(1): 1-3. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn40-1.html
NAL Call Number: SF407.P7 L3
Descriptors: *Callithrix jacchus*, foraging, feeding devices, shift in activity levels, animal welfare, mealworms.

New World Monkeys

Abbuhl, L., A. Sorrells, and M. Feurtado (2004). **Enrichment for owl monkeys: A discussion**. *Laboratory Primate Newsletter* 43(2): 10. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn43-2.html#owl
Descriptors: structural enrichment, nest boxes, feeding enrichment, mealworms, social housing, cardiomyopathy, *Aotus sp.*, owl monkeys.

Arenas Rosas, R. and A. Marquez Arias. (2003). **Enriquecimiento ambiental para monos arana (*Ateles geoffroyi*) del Instituto Nacional de Psiquiatria "Ramon de la Fuente" [Environmental enrichment of spider monkeys (*Ateles geoffroyi*) of the Instituto Nacional de Psiquiatria "Ramon de la Fuente"]**. In: *Abstracts of the 2002 Foro de Primatologia [Primatology Forum], November 21-22, 2002, Estacion de Biologia los Tuxtlas del Ibunam,* Estacion de Biologia: San Andres Tuxtlas, Mexico, p. 12.
Online: http://www.primatesmx.com/resforo02.htm
Descriptors: spider monkeys, *Ateles geoffroyi*, colony management, animal welfare, environmental enrichment, Mexico.
Language of Text: Spanish.

Boere, V. (2001). **Environmental enrichment for neotropical primates in captivity**. *Ciencia Rural* 31(3): 543-551. ISSN: 0103-8478.
NAL Call Number: S192.R4
Descriptors: captive animals, adaptation, animal welfare, behavioral needs, feeding enrichment, social housing, space requirements.

Boere, V. (2001). **Order Primates: Behavior and environmental enrichment**. In: M.E. Fowler and Z.S. Cubas (Editors), *Biology, Medicine, and Surgery of South American Wild Animals,* Iowa State University Press: Ames, Iowa, USA, p. 263-267. ISBN: 0813828465.
Descriptors: New World monkeys, environmental enrichment, animal behavior.

Boinski, S., T.S. Gross, and J.K. Davis (1999). **Terrestrial predator alarm vocalizations are a valid monitor of stress in captive brown capuchins (*Cebus apella*)**. *Zoo Biology* 18(4): 295-312. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: *Cebus apella*, brown capuchin monkeys, well-being index, vocalizations, stress indicators, environmental enrichment, abnormal behavior, plasma cortisol levels, relationship between enrichment and stress levels, threatening stimulus.

Boinski, S., S.P. Swing, T.S. Gross, and J.K. Davis (1999). **Environmental enrichment of brown capuchins (*Cebus apella*): Behavioral and plasma and fecal cortisol measures of effectiveness**. *American Journal of Primatology* 48(1): 49-68. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: No consensus exists about the quantity and variety of environmental enrichment needed to achieve an acceptable level of psychological well-being among singly housed primates. Behavioral and plasma and fecal cortisol measures were used to evaluate the effectiveness of four levels of toy and foraging enrichment provided to eight wild-caught, singly housed adult male brown capuchins (*Cebus apella*). The 16-week-long study comprised six conditions and began with a 4-week-long preexperimental and ended with a 4-week-long postexperimental period during which the subjects were maintained at baseline enrichment levels. During the intervening 8 weeks, the subjects were randomly assigned to a sequence of four 2-week-long experimental conditions: control (baseline conditions), toy (the addition of two plastic toys to each cage), box (access to a foraging box with food treats hidden within crushed alfalfa), and box & toy (the addition of two plastic toys and access to a foraging box). Behavioral responses to changes in enrichment were rapid and extensive. Within-subject repeated-measure

ANOVAs with planned post hoc contrasts identified highly significant reductions in abnormal and undesirable behaviors (and increases in normal behaviors) as the level of enrichment increased from control to toy to box to box & toy. No significant behavioral differences were found between the control and pre- and postexperimental conditions. Plasma and fecal cortisol measures revealed a different response to changing enrichment levels. Repeated-measure ANOVA models found significant changes in both these measures across the six conditions. The planned post hoc analyses, however, while finding dramatic increases in cortisol titers in both the pre- and postexperimental conditions relative to the control condition, did not distinguish cortisol responses among the four enrichment levels. Linear regressions among weekly group means in behavioral and cortisol measures (n=16) found that plasma cortisol was significantly predicted by the proportions of both normal and abnormal behaviors; as the proportion of normal behaviors increased, the plasma cortisol measures decreased. Plasma cortisol weekly group means were also significantly and positively predicted by fecal cortisol weekly group means, but no behavioral measure significantly predicted fecal cortisol weekly group means. In sum, these findings argue strongly that access to a variety of toy and foraging enrichment positively affects behavioral and physiological responses to stress and enhances psychological well-being in singly housed brown capuchins.
Descriptors: *Cebus apella*, capuchins, plasma and fecal cortisol measures, foraging enrichment, quantity and variety of environmental enrichment, manipulanda, diet, stress, normal versus abnormal behaviors and hormone levels, forage treats, psychological well-being.

Dettmer, E. and D. Fragaszy (2000). **Determining the value of social companionship to captive tufted capuchin monkeys (*Cebus apella*)**. *Journal of Applied Animal Welfare Science* 3(4): 293-304. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: *Cebus apella*, capuchin monkeys as laboratory animals, social group size, animal welfare, food deprivation, duration, psychological needs.

Dubois, M.J., J.F. Gerard, and F. Pontes (2005). **Spatial selectivity to manipulate portable objects in wedge-capped capuchins (*Cebus olivaceus*)**. *Primates* 46(2): 127-133. ISSN: 0032-8332.
Abstract: We studied the manipulative activity of five wedge-capped capuchins (*Cebus olivaceus*) confronted with different types of unfamiliar and portable objects: wooden blocks, plastic rings, spoons, and coconuts. Combinatorial manipulations involving two portable objects of the same type were quite frequent. The lately introduced objects, whatever their kind, appeared as the most attractive. Nevertheless, some objects remained very attractive throughout the overall experiment, especially the wooden blocks which elicited more combinatorial and striking behaviors than the other objects. Concerning space, we observed that the individuals choose specific locations to perform their manipulative acts. The spatial distributions of these acts were more concentrated, and less concordant between individuals, in the present study than in two others conducted with the same group but involving the manipulation of familiar objects. This suggests that individual differences were more marked when the subjects manipulated unfamiliar objects than when they manipulated familiar ones. This finding may have applications when the members of a group have to benefit from an enrichment of their environment.
Descriptors: wedge-capped capuchins, *Cebus olivaceus*, object manipulation, novelty important in object selection by monkeys, spatial locations chosen by monkeys to manipulate objects, individual differences in manipulative activity, benefit of enrichment programs, social environment, Brazil.

Fekete, J.M., J.L. Norcross, and J.D. Newman (2000). **Artificial turf foraging boards as environmental enrichment for pair-housed female squirrel monkeys**. *Contemporary Topics in Laboratory Animal Science* 39(2): 22-26. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: We investigated the use of artificial turf foraging boards to determine if providing captive squirrel monkeys an opportunity for semi-natural foraging behavior would 1) alter the monkeys' time budget to better approximate that seen in wild populations, 2) reduce the stereotypic, self-injurious, and aggressive behavior occasionally seen in captive squirrel

monkeys, and 3) provide sustained enrichment. Five groups of pair-housed female squirrel monkeys were videotaped the week prior to, the week following, and for 2 weeks during the enrichment phase, when treat-enhanced boards were provided for 2 h daily. During the first 30 min of daily enrichment, inactivity declined 35.3%, locomotion increased 3.8%, and board-related behaviors occupied 36.3% of the activity budget; these changes were not evident after 1.5 h. Stereotypic behavior (pacing, headswinging, tailchewing) and aggression were not altered by the foraging opportunity. The foraging board retained the interest of the subjects across 2 weeks in the same daily pattern. Use of the foraging board altered the squirrel monkeys' time budget to become more like activity patterns seen in wild populations.
Descriptors: turf grass foraging boards, no effect of enrichment on stereotypies and aggression, animal husbandry , cage design, foraging behavior, *Saimiri sp.*, female squirrel monkeys, food preferences, time budget, activity patterns.

Kondo, S.Y., E.B. Yudko, and L.K. Magee (2003). **A novel approach for documentation and evaluation of activity patterns in owl monkeys during development of environmental enrichment programs**. *Contemporary Topics in Laboratory Animal Science* 42(3): 17-21. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: *Aotus sp.*, owl monkeys, effects of an environmental enrichment program, videotape, animal behavior, activity patterns, ethological analysis software.

Ludes Fraulob, E. (1999). **Enrichissement environnemental: Etude des variations comportementales liees a l'utilisation de differents types de litieres chez *Cebus capucinus*. [Environmental enrichment: Evaluation of the behavioural modifications of in the presence of four kinds of litter in *Cebus capucinus*]**. *Primatologie* 2: 435-448. ISSN: 1279-8304.
Descriptors: *Cebus capucinus*, capuchin monkeys, animal housing, litter, peat bathing, role of environmental enrichment, animal behavior.
Language of Text: French; Summary in English and French.

Ludes Fraulob, E. and J.R. Anderson (1999). **Behaviour and preferences among deep litters in captive capuchin monkeys (*Cebus capucinus*)**. *Animal Welfare* 8(2): 127-134. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: *Cebus capucinus*, capuchins, deep litter housing, maize cobs, wood chips, wood wool, peat, animal behavior, foraging, enrichment, play behavior.

Savastano, G. (2004). **Enrichment options: Variations from the norm**. *Animal Keepers' Forum* 31(4): 153-155. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: Callitrichid, Cebids, visual enrichment, snowballs, cardboard boxes, swings.

Tondu, M., C. Lejeune, and M. Mercier (2000). **Etudes ethologiques sur une colonie de *Cebus apella* vivant en captivite suite a divers enrichmissements envionnementaux. [Ethological evaluation of some environmental enrichments in a captive colony of *Cebus apella*]**. *Folia Primatologica* 71(4): 266. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: psychological well-being, *Cebus apella*, brown capuchin monkeys, stereotypic behavior, social interactions, play behavior, object manipulation, PVC pipes, meeting abstract.
Language of Text: French; Summary in English.
Notes: 11th Annual Meeting of the Societe Francophone de Primatologie, Paris, France; September 29-October 2, 1999.

Visalberghi, E., G. Sabbatini, M. Stammati, and E. Addessi (2003). **Preferences towards novel foods in *Cebus apella*: The role of nutrients and social influences.** *Physiology and Behavior* 80(2-3): 341-349. ISSN: 0031-9384.
NAL Call Number: QP1.P4

Descriptors: preferences to novel foods, animal behavior, social influences, tufted capuchins, *Cebus apella*, energy content.

Webster, S.J.G. (2003). **Can primates receive adequate primary diet from an enrichment unit?** *Animal Keepers' Forum* 30(10): 420-422. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: *Cebus capucinus*, feeding enrichment, diet, dietary needs, food dispensers.

Williams, L.E., A. Steadman, and B. Kyser (2000). **Increased cage size affects *Aotus* time budgets and partner distances.** *American Journal of Primatology* 51(Suppl. 1): 98. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: social housing, perches, nest boxes, instantaneous behavior scans, activity budgets, *Aotus sp.*, owl monkeys, meeting abstract.
Notes: 23rd Annual Meeting of The American Society of Primatologists, Denver, Colorado, USA; June 21-24, 2000.

Lemurs, Lorises and Tarsiers

Abels, J. (2004). **Black and white ruffed lemur nest box**. *Laboratory Primate Newsletter* 43(1): 15. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn43-1.html#nest
Descriptors: nest box description, answer to list-serve question, nesting material, number of nest boxes offered.

Caltran, E., D. Grassi, R. Perbellini, E. Baistrocchi, and M. Turchetto (2002). **Effects of structural enrichment on the activity of a group of captive red ruffed lemurs (*Varecia variegata rubra*)**. *Advances in Ethology* 37: 28. ISSN: 0931-4202.
Descriptors: animal behavior, abnormal behavior, captivity, feeding, structural enrichment, well-being, zoos, meeting abstract.
Notes: 4th International Symposium on Physiology and Behaviour of Wild and Zoo Animals, Berlin, Germany; September 29-October 2, 2002.

Campbell, J.L., K.M. Glenn, B. Grossi, and J.H. Eisemann (2001). **Use of local North Carolina browse species to supplement the diet of a captive colony of folivorous primates (*Propithecus sp.*)**. *Zoo Biology* 20(6): 447-461. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: lemurs, Indriidae, browse plants, liquid ambarstyraciflua, chemical composition, fiber content, nitrogen content, voluntary intake, dry matter, laboratory animals, seasonal variation.

Fitch Snyder, H. and H. Schulze (Editors) (2001). ***Management of Lorises in Captivity: A Husbandry Manual for Asian Lorisines (Nycticebus and Loris Ssp.),*** Center for Reproduction of Endangered Species (CRES), Zoological Society of San Diego: San Diego, California, 104 p.
Online: http://www.loris-conservation.org/database/captive_care/manual/
Abstract: This online manual is available to read in html or pdf format and is intended to provide basic husbandry guidelines for loris managers, caretakers and veterinarians. There are chapters containing information on taxonomy, behavior, reproduction, nutrition, infant care, health, and habitat design. Information on enrichment is found in the chapter on habitat design. A list of references is also provided.
Descriptors: pygmy loris, taxonomy, environmental enrichment, habitat design, captive management, species survival plan (SSP).

Grams, K. and J. Roletto (2001). **Fabricated trees**. *Animal Keepers' Forum* 28(2): 58-60. ISSN: 0164-9531.
NAL Call Number: QL77.5.A54
Descriptors: parrots, small primates, lemurs, artificial trees in animal exhibits, tools, building enrichment items.

Henton, R. (2000). **The lifestyle of the loris: An investigation into the activity and husbandry of pygmy slow lorises (*Nycticebus pygmaeus*) at Paignton Zoo Environmental Park**. In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 43-46.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: Lorisinae, pygmy slow loris, *Nycticebus pygmaeus*, reverse lighting programs, nocturnal housing in zoos, enclosure modifications, diet, activity budget differences between wild and captive animals, light measurements.

Hosey, G.R. (2000). **A glimpse into the lemur mind**. In: *Proceedings of the 2nd Annual Symposium on*

Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Devon, UK, Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 5-10.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: lemurs, learning and cognition, effects of separation, research and experimentation, research performed in zoos, novel behaviors.

Hughes, V.L. and D.J. Price. (2000). **Black and white ruffed lemurs (*Varecia variegata variegata*) at Shaldon Zoo. Can environmental enrichment affect their behaviour?** In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Devon, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 47-52.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: *Varecia variegata variegata*, black and white ruffed lemurs, zoo settings, behavioral observations, foraging device, enrichment device based on natural foraging postures, effect of enrichment on behavior of group housed animals, Shaldon Zoo, England.

Hutchings, K. and H. Mitchell. (2003). **A preliminary investigation of olfactory enrichment for captive ruffed lemurs.** In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, England, p. 288.
Descriptors: *Varecia variegata variegata*, role of olfaction in social interactions, olfactory enrichment, Marwell Zoological Park, animal behavior, scent-marked objects, novel scents.

Kerridge, F.J. (2005). **Environmental enrichment to address behavioral differences between wild and captive black-and-white ruffed lemurs (*Varecia variegata*).** *American Journal of Primatology* 66(1): 71-84. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: I compared the behaviors of wild Varecia variegata living in a Malagasy rain forest with those of caged groups living in zoos in the United Kingdom in order to design environmental enrichment to encourage more natural behaviors. Comparisons were made between wild and captive animals in terms of activity budgets (instantaneously sampled at 1-min intervals) and social and solitary behaviors, which were continuously recorded for focal individuals. I followed the same sampling protocol during behavioral enrichment experiments, with additional monitoring of the amount and type of food consumed, and with more detailed observations of feeding behavior. No significant differences were found in resting or moving between wild and captive V. variegata. However, captive V. variegata spent more time on self-grooming and social behaviors, and less time feeding than wild V. variegata. There was also a lack of manual manipulation of food items. Behavioral enrichment experiments were carried out in which whole rather than chopped fruit was provided and presented in a more naturalistic manner. With this method of dietary presentation, manual manipulation of dietary items increased. Time spent feeding also increased significantly. Captive conservation breeding programs should not be wholly concerned with maintaining a diverse gene pool-they should also be concerned with conserving species-typical behaviors, especially if they are to produce behaviorally intact captive animals that can be reintroduced to the wild with minimal training, financial resources, and loss of individuals.
Descriptors: animal behavior, Lemuridae, motor activity, feeding behavior, activity budget differences between wild and captive animals, more time spent self-grooming and social behavior in captive animals, conserving species-typical behavior for reintroductions, Madagascar, zoo environments compared to the wild, *Varecia variegata*, ruffed lemurs.

Perbellini, R., D. Grassi, E. Caltran, E. Baistrocchi, and M. Turchetto (2002). **Effects of nutrition enrichment on the activity of a group of red ruffed lemurs (*Varecia variegata rubra*).** *Advances in Ethology* 37: 62. ISSN: 0931-4202.
Descriptors: lemurs, aggression, dominance hierarchy, feeding and grooming behavior, nutritional enrichment, social interactions, meeting abstract.
Notes: 4th International Symposium on Physiology and Behaviour of Wild and Zoo Animals, Berlin, Germany; September 29-October 2, 2002.

Schaefer, M.S. and L.T. Nash (2004). **Cage enrichment for galagos: A cautionary tale**. *Laboratory Primate Newsletter* 43(1): 1-4. ISSN: 0023-6861.
Online: http://www.brown.edu/Research/Primate/lpn43-1.html
Descriptors: *Galago senegalensis braccatus*, housing techniques, cage enrichment, animal behavior.

Sha, J.C.M. and C. Agoramoorthy (2004). **Husbandry and enrichment spectral tarsiers (*Tarsius spectrum*) in captivity**. *Folia Primatologica* 75(Suppl. 1): 213. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: *T. spectrum*, animal welfare, environmental enrichment, meeting abstract.

Tarou, L.R., M.A. Bloomsmith, and T.L. Maple (2005). **Survey of stereotypic behavior in prosimians**. *American Journal of Primatology* 65(2): 181-196. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Captive animals have been observed to perform a variety of stereotypic behaviors. However, little is known about stereotypic behavior in prosimians. We sent surveys to 96 AZA-accredited institutions to examine stereotypic behavior in these primates. Forty-eight surveys were returned, providing information on 440 individuals of 10 genera. According to the responses, 13.2% of the prosimians surveyed exhibited some form of stereotypic behavior. Pacing was the most common behavior. A logistic regression was used to examine intrinsic characteristics that might influence the performance of stereotypic behavior. The genus of the prosimian was a significant predictor of stereotypic behavior. Individuals of the genus *Varecia* and *Microcebus* were more likely to engage in stereotypic behavior than members of the other genera. Rearing history, age, and sex were not significant predictors of stereotypic behavior. To examine the influence of extrinsic variables on stereotypic behavior, we transformed the data into the percentage of individuals within the enclosure that were reported to exhibit stereotypic behavior, and analyzed them at the enclosure level using a general linear model (GLM) analysis of variance (ANOVA). The only environmental variable that significantly predicted stereotypic behavior was the frequency with which enrichment was provided. Frequent enrichment was provided to those exhibits with a higher percentage of prosimians that engaged in stereotypic behavior. The results of this survey suggest that stereotypic behavior in prosimians may be associated with intrinsic factors (i.e., individual or genus differences) in addition to extrinsic factors related to housing. This knowledge may be helpful in identifying the causes of and effective treatments for stereotypic behavior in prosimians.
Descriptors: abnormal behavior, pacing, stereotypies, *Varecia sp.*, *Microcebus sp.*, intrinsic factors, zoo animals, genus differences, housing and individual effects on stereotypic behavior, captive prosimians.

Thwaite, J. (2000). **Environmental enrichment research into the effects of different feeding devices upon the behaviour of a group of red-ruffed lemurs**. In: *Proceedings of the 2nd Annual Symposium on Zoo Research, July 6-7, 2000, Paignton Zoo Environmental Park, Paignton, Denton, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 121.
Online: http://www.biaza.org.uk/resources/library/images/ARSP2.pdf
Descriptors: red-ruffed lemurs, husbandry of captive animals, zoo settings, feeding devices, effects of enrichment on feeding behavior, using check sheets and brief observations to quantify behavior, Chester Zoo, UK, meeting abstract.

Vasey, N. (2005). **New developments in the behavioral ecology and conservation of ruffed lemurs (*Varecia* sp.)**. *American Journal of Primatology* 66(1): 1-6. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: The papers in this issue were presented at a symposium during the 25th Annual Meeting of the American Society of Primatologists held in Oklahoma City, Oklahoma, in June 2002. This symposium brought together many of the scientists who have contributed to our knowledge of ruffed lemur ecology, behavior, and conservation in the past decade. One objective was to share and compare key findings about ruffed lemurs (Varecia) resulting from long-term field studies at various sites in Madagascar. A second objective was to cross-fertilize work being

done in the wild with that being done in captivity, with the aim of advancing a common conservation mission for this critically endangered genus. Varecia is a prime candidate for synthetic assessments such as these because it has now been studied in both the northern and southern reaches of its geographic range, and has also been the focus of a captive-to-wild reinforcement project. The papers in this issue contribute to 1) the establishment of reference ranges for a suite of physiological parameters in healthy wild Varecia populations; 2) environmental enrichment aimed at preserving species-typical behaviors in captivity; 3) an understanding of how forest structure, floristic composition, and fruiting phenology in areas with differing disturbance histories correlate with the natural occurrence and abundance of Varecia; 4) primary knowledge concerning dominance relations between the sexes and group leadership in wild Varecia; and 5) primary knowledge concerning how wild Varecia, with their unusual reproductive pattern and heavy reliance on fruit, modulate their activity budgets seasonally and in tandem with reproductive stages.
Descriptors: introductory paper to journal issue, wild populations, captive wild animals, environmental enrichment use to preserve species-typical behaviors, forest structure, dominance relations between lemurs, Madagascar, ruffed lemurs, *Varecia*, Lemuridae physiology, conservation of natural resources, understanding natural ecosystems.

Watson, S., A. Gray, E. Taylor, B. Johnson, B. Fahm, a. Mcgee, W. Bingham, and P. Banks (2002).
Efficacy of environmental enrichment for Garnett's bushbaby (*Otolemur garnettii*).
American Journal of Primatology 57(Suppl. 1): 38-39. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: manipulanda, vertical space, enriched environment, animal behavior, U.S. Animal Welfare Act, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Training

Abello, M., M. Velasco, and F. Esteban (1999). **A training programme for a male gorilla at the Barcelona Zoo.** *International Zoo News* 46(7): 418-420. ISSN: 0020-9155.
NAL Call Number: QL76.I58
Descriptors: semen collection, gorillas in zoos, *Gorilla gorilla*, Barcelona Zoo, Spain, animal training program.

Ball, R.L. and A. Frazier (2002). **Operant conditioning as a tool for improved veterinary care in zoo animals.** *Advances in Ethology* 37: 22. ISSN: 0301-2808.
NAL Call Number: 410 Z35B
Descriptors: environmental enrichment, preventative health care programs, psychological health, stress reduction, training and desensitization, role of the veterinarian, meeting abstract.
Notes: 4th International Symposium on Physiology and Behaviour of Wild and Zoo Animals, Berlin, Germany, September 29-October 2, 2002.

Bassett, L., H.M. Buchanan Smith, J. McKinley, and T.E. Smith (2003). **Effects of training on stress-related behavior of the common marmoset (*Callithrix jacchus*) in relation to coping with routine husbandry procedures.** *Journal of Applied Animal Welfare Science* 6(3): 221-233. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Using positive reinforcement, J. McKinley trained 12 common marmosets (*Callithrix jacchus*) to provide urine samples on request. The study then expcsed the marmosets to mildly stressful, routine husbandry procedures (i.e., capture and weighing). The nonhuman animals spent less time inactive poststressor as opposed to prestressor. L. Bassett collected matched behavioral data from 12 nontrained marmosets who were less accustomed to human interaction. These animals spent significantly more time self-scratching and locomoting as well as less time inactive, poststressor. Collapsed data from the 2 populations showed increased scent marking, poststressor. These results suggest that locomotion, self-scratching, and scent marking are useful, noninvasive behavioral measures of stress and, thus, reduced welfare in the common marmoset. Overall, nontrained animals showed more self-scratching than did their trained counterparts. It was not possible to collect urine from nontrained marmosets. In response to the stressor, however, trained animals showed no significant change in excreted urinary cortisol. These results suggest that training marmosets may allow them to cope better with routine laboratory procedures. Comment On: J Appl Anim Welf Sci. 2003;6(3):209-20
Descriptors: animal husbandry, animal behavior, operant conditioning, monkey diseases, animal welfare, hydrocortisone in urine, stress.

Bell, B. and P. Khan. (2001). **Training multi-task medical behaviors in the bonobo (*Pan paniscus*).** In: *The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo,* Chicago Zoological Society: Brookfield, Illinois, USA, p. 128-130. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACBell.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: training for medical behavior, bonobos, *Pan paniscus*, ultrasound measurements, squeeze restraint, routine blood draws, Milwaukee County Zoo, USA.

Bloomsmith, M.A., K.C. Baker, S.K. Ross, and S.P. Lambeth (1999). **Comparing animal training to non-training human interaction as environmental enrichment for chimpanzees.** *American Journal of Primatology* 49(1): 35-36. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: chimpanzees, *Pan troglodytes*, animal care, animal training, environmental enrichment, non-training human interactions, meeting abstract.
Notes: 22nd Annual Meeting of the American Society of Primatologists, New Orleans, Louisiana, USA; August 12-16, 1999.

Buchanan-Smith, H.M., J. McKinley, V. Bowell, A. Rennie, and M.J. Prescott (2004). **Positive reinforcement training as a refinement for laboratory-housed primates**. *Folia Primatologica* 75(Suppl. 1): 131. ISSN: 0015-5713.
NAL Call Number: QL737.P9F6
Descriptors: animal welfare, captive primates, husbandry, scientific validity, training to cooperate in routine procedures.

Buchanan-Smith, H.M. (2003). **The benefits of positive reinforcement training and its effects on human nonhuman animal interactions.** In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 21-26.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: operant conditioning, husbandry, animal training, zoos, overview, human-animal relationships.

Colahan, H. and C. Breder (2003). **Primate training at Disney's Animal Kingdom**. *Journal of Applied Animal Welfare Science* 6(3): 235-246. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: A training program has been in place at Disney's Animal Kingdom since the nonhuman animals first arrived at the park. The Primate Team and the Behavioral Husbandry Team have worked together closely to establish a philosophy and framework for this program. This framework emphasizes setting goals, planning, implementing, documenting, and evaluating. The philosophy focuses on safety, staff training, and an integrated approach to training as an animal management tool. Behaviors to be trained include husbandry and veterinary as well as behaviors identified for specific species, individuals, or situations. Input from all the teams was used to prioritize these behaviors. Despite the challenges to maintaining such a program, the benefits to animal care and welfare have been enormous.
Descriptors: animal husbandry, animal behavior, operant conditioning, positive reinforcement, safety, animal welfare.

Coleman, K., L.A. Tully, and J.L. McMillan (2005). **Temperament correlates with training success in adult rhesus macaques.** *American Journal of Primatology* 65(1): 63-71. ISSN: 1098-2345.
NAL Call Number: QL737.P9A5
Abstract: In recent years there has been a marked increase in awareness of issues involving the psychological well-being of nonhuman primates (NHPs) used in biomedical research. As a result, many facilities are starting to train primates to voluntarily cooperate with veterinary, husbandry, and research procedures, such as remaining still for blood draws or injections. Such training generally reduces the stress associated with these procedures, resulting in calmer animals and, ultimately, better research models. However, such training requires great investments in time, and there can be vast individual differences in training success. Some animals learn tasks quickly, while others make slower progress in training. In this study, we examined whether temperament, as measured by response to a novel food object, correlated with the amount of time it took to train 20 adult female rhesus macaques to perform a simple task. The monkeys were categorized as "exploratory" (i.e., inspected a novel object placed in the home cage within 10 sec), "moderate" (i.e., inspected the object within 10-180 sec), or "inhibited" (i.e., did not inspect the object within 3 min). We utilized positive reinforcement techniques to train the monkeys to touch a target (PVC pipe shaped like an elbow) hung on their cage. Temperament correlated with training success in this study (Pearson chi2=7.22, df=2, P=0.03). We easily trained over 75% of the animals that inspected the novel food (i.e., exploratory or moderate individuals) to touch the target. However, only 22% of the inhibited monkeys performed the task. By knowing which animals may not respond to conventional training methods, we may be able to develop alternate training techniques to address their specific needs. In addition, these results will allow us to screen monkeys to be assigned to research projects in which they will be trained, with the goal of obtaining the best candidates for those studies.
Descriptors: inhibition psychology, learning, *Macaca mulatta* , reinforcement psychology, temperament, positive reinforcement training.

Craig, J. (2004). **Training an older orangutan (*Pongo pygmaeus abelii*) for voluntary injection**. In: *Animal Behavior Management Alliance (ABMA) Conference Proceedings 2004, April 4-9, 2004, Baltimore, Maryland, USA,* Animal Behavior Management Alliance: p. 68. [CD-Rom]
Descriptors: chemical immobilization, shaping behavior, presentation of body parts, zoos.

Franklin, J.A. and S.R. Taylor. (2000). **The health management of orangutans through training**. In: *American Zoo and Aquarium Association Regional Conference Proceedings,* American Zoo and Aquarium Association: Wheeling, West Virginia, USA, p. 1-2. ISSN: 1088-0402.
NAL Call Number: QL76.5.U6A47
Descriptors: *Pongo pygmaeus*, care in captivity, health management through training.

Friscino, B., C. Gai, A. Kulick, M. Donnelly, R. Rokar, L. Anderson, and S. Iliff (2003). **Positive reinforcement training as a refinement of a macaque biliary diversion model**. *Contemporary Topics in Laboratory Animal Science* 42(4): 80. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Descriptors: macaques, refinement techniques, bile duct diversion, animal models, positive reinforcement training, blood and bile collection, jacket-training, cannula system, pouch presentation, time taken to train animals, effect on stress, meeting abstract.
Notes: 2003 AALAS National Meeting, Seattle, Washington, USA; October 12-16, 2003.

Good, S. (2000). **A survey of operant conditioning in AZA institutions**. In: *American Zoo and Aquarium Association Regional Conference Proceedings,* American Zoo and Aquarium Association: Wheeling, West Virginia, USA, p. 27-31.
Descriptors: use of operant conditioning in zoos, North America, survey.

Harris, L.D., E.J. Briand, R. Orth, and G. Galbicka (1999). **Assessing the value of television as environmental enrichment for individually housed rhesus monkeys: A behavioral economic approach.** *Contemporary Topics in Laboratory Animal Science* 38(2): 48-53. ISSN: 1060-0558.
NAL Call Number: SF405.5.A23
Abstract: The goal of this study was to evaluate television as a source of environmental enrichment for individually housed rhesus monkeys (*Macaca mulatta*) by using the concepts of behavioral economics. Phase I entailed the use of operant conditioning to assess the behavior of eight rhesus monkeys given the opportunity to control their environment through lever activation of a television (TV). Success in shaping was variable, and only two animals successfully acquired lever pressing. Phase II used an alternating reinforcement/ extinction procedure as a control method to determine the degree to which lever pressing depended on TV presentation. Both animals responded with more lever pressing on the days when lever pressing produced TV. The first animal, tested with the alternating reinforcement/extinction procedure for 12 weeks yielded a mean significant difference of 3.85 ($p = 0.036$); the second assessed for 9 weeks was associated with a mean significant difference of 6.0 ($p = 0.018$). Therefore, TV (and not lever pressing itself) was positively reinforcing. The final phase of the study progressively increased the fixed ratio (FR) from 1 to 8. Linear regression of the data points, plotted as the log of price (or FR) vs the consumption of TV, revealed a significantly negative slope (-2.179, p, 0.05) and accounted for 89% of the variance. The negative demand curve suggested that TV is not a valued commodity and is highly elastic. TV provided to individually housed rhesus monkeys appears to be a weakly positive reinforcer for some animals, which may contribute to overall environmental enrichment.
Descriptors: *Macaca mulatta*, rhesus macaque, operant conditioning, animal control of television viewing, shaping behavior, positive reinforcement training, single housing.

Kuehn, B.M. (2002). **Zoo animal welfare boosted by environmental enrichment, positive reinforcement training**. *Journal of the American Veterinary Medical Association* 221(11): 1532. ISSN: 0003-1488.
NAL Call Number: 41.8 Am3
Descriptors: effects of captivity, animal well-being, protected contact, social interactions, desensitization, enrichment strategies, training of animals.

Lambeth, S.P., J. Hau, J.E. Perlman, M. Martino, and S.J. Schapiro (2006). **Positive reinforcement training affects hematologic and serum chemistry values in captive chimpanzees (*Pan troglodytes*)** . *American Journal of Primatology* 68(3): 245-256. ISSN: 1098-2345.
NAL Call Number: QL737.P9A5
Descriptors: positive reinforcement training, stress reduction, behavioral management, *Pan troglodytes*, injection training, hematology and serum chemistry profiles, physiological measures, chimpanzees.

Lambeth, S.P., J.E. Perlman, and S.J. Schapiro (2000). **Positive reinforcement training paired with videotape exposure decreases training time investment for a complicated task in female chimpanzees**. *American Journal of Primatology* 51(Supplement 1): 79-80(Suppl. 1): 79-80. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: training complicated tasks, time investment, videotape use, animal behavior, meeting abstract.

Laule, G.E. (2003). **Positive reinforcement training and environmental enrichment: Enhancing animal well-being**. *Journal of the American Veterinary Medical Association* 223(7): 969-973. ISSN: 0003-1488.
NAL Call Number: 41.8 Am3
Descriptors: animal husbandry, zoo animals, animal behavior, enriched environment, operant conditioning, animal welfare.

Laule, G.E., M.A. Bloomsmith, and S.J. Schapiro (2003). **The use of positive reinforcement training techniques to enhance the care, management, and welfare of primates in the laboratory**. *Journal of Applied Animal Welfare Science* 6(3): 163-173. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Handled frequently and subjected to a wide range of medical procedures that may be particularly invasive, nonhuman animals in a laboratory setting have unique needs. To produce the most reliable research results and to protect and enhance the well-being of the animals, it is desirable to perform these procedures with as little stress for the animals as possible. Positive reinforcement training can use targeted activities and procedures to achieve the voluntary cooperation of nonhuman primates. The benefits of such work include diminished stress on the animals, enhanced flexibility and reliability in data collection, and a reduction in the use of anesthesia. Training also provides the means to mitigate social problems, aid in introductions, reduce abnormal behavior, enhance enrichment programs, and increase the safety of attending personnel. This article describes the application of operant conditioning techniques to animal management.
Descriptors: animal husbandry, laboratory animals, operant conditioning, primate physiology and psychology, animal welfare, animal behavior.

Laule, G. and M. Whittaker (1999). **Positive reinforcement training and medical management of captive animals**. *Erkrankungen Der Zootiere* 39: 277-282. ISSN: 0138-5003.
Descriptors: behavioral techniques, husbandry and medical management using animal training, animal handling, zoos.
Language of Text: English; Summary in English, German.

McCormick, W. (2003). **How enriching is training?** In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park, Winchester, UK,* The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 9-19.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: enrichment and training, elephants, activity budgets, behavioral diversity, increase in object manipulation with enrichment, training may not be enriching, Paignton Zoo, UK.

McDermott, F.A.P. and T.E. Smith. (2003). **Operant conditioning can be used to train common marmosets (*Callithrix jacchus*) to scent-mark on demand**. In: *Proceedings of the Fifth Annual*

Symposium on Zoo Research, Marwell Zoological Park, Winchester, UK, The Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 20.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: common marmosets, *Callithrix jacchus*, training for natural behaviors, scent-marking, positive reinforcement, age and sex differences, six different social groups, meeting abstract.

McKinley, J. and H.M. Buchanan-Smith. (2003). **Improving the animal-human relationship with laboratory-housed common marmosets (*Callithrix jacchus*): Increased interactions and positive reinforcement training**. In: *Proceedings of the Fifth Annual Symposium on Zoo Research, July 7-8, 2003, Marwell Zoological Park, Winchester, UK,* Federation of Zoological Gardens of Great Britain and Ireland: London, UK, p. 27-37.
Online: http://www.biaza.org.uk/resources/library/images/ARSP5.pdf
Descriptors: operant conditioning, common marmosets, *Callithrix jacchus*, pair housed animals, laboratory research settings, animal-human relationships, decrease in stress-related behaviors, positive reinforcement training, no change in aggression.

McKinley, J., H.M. Buchanan Smith, L. Bassett, and K. Morris (2003). **Training common marmosets (*Callithrix jacchus*) to cooperate during routine laboratory procedures: Ease of training and time investment**. *Journal of Applied Animal Welfare Science* 6(3): 209-220. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: The first author trained 12 laboratory-housed common marmosets (*Callithrix jacchus*) in pairs to assess the practicality of positive reinforcement training as a technique in the management of these nonhuman animals. Behaviors taught were (a) target training to allow in homecage weighing and (b) providing urine samples. Between 2 to 13, 10-minute training sessions established desired behaviors. Training aggressive animals only after they had been fed eliminated aggression during training. Trained animals proved extremely reliable, and data collection using trained animals was considerably faster than collection using current laboratory techniques. The results suggest that positive reinforcement training is a practical option in the management of laboratory-housed marmosets. Comment In: J Appl Anim Welf Sci. 2003;6(3):221-33
Descriptors: animal behavior, Callithrix, operant conditioning, positive reinforcement, animal welfare, husbandry, laboratory animal management.

Perlman, J.E., T.R. Bowsher, S.N. Braccini, T.J. Kuehl, and S.J. Schapiro (2003). **Using positive reinforcement training techniques to facilitate the collection of semen in chimpanzees (*Pan troglodytes*)**. *American Journal of Primatology* 60(Supplement 1): 77-78(Suppl. 1): 77-78. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: semen collection techniques, apes, meeting abstract.

Perlman, J.E., F.A. Guhad, S. Lambeth, T. Fleming, D. Lee, M. Martino, and S. Schapiro (2001). **Using positive reinforcement training techniques to facilitate the assessment of parasites in captive chimpanzees**. *American Journal of Primatology* 54(Suppl. 1): 56. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: animal care, parasitology, meeting abstract.

Perlman, J.E., B.A. Boudreau, and S.J. Schapiro (1999). **Affiliative behaviors of group housed rhesus macaques are altered by positive reinforcement training**. *American Journal of Primatology* 49(1): 86. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: group housing, animal training, meeting abstract.

Prescott, M.J. and H.M. Buchanan Smith (2003). **Training nonhuman primates using positive reinforcement techniques**. *Journal of Applied Animal Welfare Science* 6(3): 157-161. ISSN:

1088-8705.
NAL Call Number: HV4701.J68
Descriptors: operant conditioning, animal welfare, animal behavior, primate psychology.

Raper, J.R., M.A. Bloomsmith, A. Stone, and L. Mayo (2002). **Use of positive reinforcement training to decrease stereotypic behaviors in a pair of orangutans (*Pongo pygmaeus*)**. *American Journal of Primatology* 57(Suppl. 1): 70-71. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Descriptors: zoo animal behavior, positive reinforcement training, well-being, reproductive behavior, social behavior, stereotypic behavior, primates in zoos, meeting abstract.
Notes: 25th Annual Meeting of The American Society of Primatologists, Oklahoma City, Oklahoma, USA; June 1-4, 2002.

Reinhardt, V. (2003). **Working with rather than against macaques during blood collection**. *Journal of Applied Animal Welfare Science* 6(3): 189-197. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Training macaques to cooperate during blood collection is a practicable and safe alternative to the traditional procedure implying forced restraint. It takes a cumulative total of about 1 hr to train an adult female or adult male rhesus macaque successfully to present a leg voluntarily and accept venipuncture in the homecage. Cooperative animals do not show the significant cortisol response and defensive reactions that typically occur in animals who are forcibly restrained during this common procedure.
Descriptors: blood collection, cooperative behavior, *Macaca mulatta*, physical restraint, animal welfare, stress.

Reinhardt, V. (2002). **The myth of the aggressive monkey**. *Journal of Applied Animal Welfare Science* 5(4): 321-330. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: *Macaca mulatta*, laboratory animals, aggression, animal stress, cages, restraint of animals, training of animals, group housing, animal technicians, animal welfare, pair housing.

Reinhardt, V. and A. Reinhardt (2000). **Blood collection procedure of laboratory primates: a neglected variable in biomedical research**. *Journal of Applied Animal Welfare Science* 3(4): 321-333. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Descriptors: monkeys, laboratory animals, *Macaca mulatta*, *Cercopithecus aethiops*, blood sampling , restraint of animals, mental stress, hormone secretion, ketamine, injection, experimental design, animal welfare, animal use refinement, animal use reduction.

Savastano, G., A. Hanson, and C. McCann (2003). **The development of an operant conditioning training program for new world primates at the Bronx Zoo**. *Journal of Applied Animal Welfare Science* 6(3): 247-261. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: This article describes the development of an operant conditioning training program for 17 species of New World primates at the Bronx Zoo. To apply less invasive techniques to husbandry protocols, the study introduced behaviors-hand feeding, syringe feeding, targeting, scale and crate training, and transponder reading-for formal training to 86 callitrichids and small-bodied cebids housed in 26 social groups. Individual responses to training varied greatly, but general patterns were noted among species. With the exception of lion tamarins, tamarins responded more rapidly than marmosets, Bolivian gray titi monkeys, and pale-headed saki monkeys in approaching trainers and learning behaviors. Marmosets, in comparison to most tamarins, had longer attention spans. This meant that fewer, lengthier sessions were productive whereas shorter, more frequent sessions were most successful for tamarins. Among the cebids, pale-headed saki monkeys needed relatively few sessions to perform basic and advanced behaviors whereas Bolivian gray titi monkeys were less responsive and progressed at a deliberate pace. Marked changes in the animals' behavior during daily husbandry procedures,

their voluntary participation in training activities, and the disappearance of aggressive threats toward care staff indicated that training reduced stress and improved the welfare of the animals. During daily training displays, zoo visitors experienced interactive animals while learning the importance of low-stress animal husbandry.
Descriptors: Cebidae, positive reinforcement training, husbandry, zoos, animal welfare, animal behavior.

Schapiro, S.J., M.A. Bloomsmith, and G.E. Laule (2003). **Positive reinforcement training as a technique to alter nonhuman primate behavior: quantitative assessments of effectiveness**. *Journal of Applied Animal Welfare Science* 6(3): 175-187. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: Many suggest that operant conditioning techniques can be applied successfully to improve the behavioral management of nonhuman primates in research settings. However, relatively little empirical data exist to support this claim. This article is a review of several studies that discussed applied positive reinforcement training techniques (PRT) on breeding/research colonies of rhesus macaques (Macaca mulatta) and chimpanzees (Pan troglodytes) at The University of Texas M. D. Anderson Cancer Center and measured their effectiveness. Empirical analyses quantified the amount of time required to train rhesus monkeys to come up, station, target, and stay. Additionally, a study found that time spent affiliating by female rhesus was changed as a function of training low affiliators to affiliate more and high affiliators to affiliate less. Another study successfully trained chimpanzees to feed without fighting and to come inside on command. PRT is an important behavioral management tool that can improve the care and welfare of primates in captivity. Published empirical findings are essential for managers to assess objectively the utility of positive reinforcement training techniques in enhancing captive management and research procedures.
Descriptors: animal welfare, animal behavior, operant conditioning, learning, *Macaca mulatta*, meta analysis, social behavior.

Schapiro, S.J., J.E. Perlman, and B.A. Boudreau (2001). **Manipulating the affiliative interactions of group-housed rhesus macaques using positive reinforcement training techniques**. *American Journal of Primatology* 55(3): 137-149. ISSN: 0275-2565.
NAL Call Number: QL737.P9A5
Abstract: Social housing, whether continuous, intermittent, or partial contact, typically provides many captive primates with opportunities to express affiliative behaviors, important components of the species-typical behavioral repertoire. Positive reinforcement training techniques have been successfully employed to shape many behaviors important for achieving primate husbandry goals. The present study was conducted to determine whether positive reinforcement training techniques could also be employed to alter levels of affiliative interactions among group-housed rhesus macaques. Twenty-eight female rhesus were divided into high (n = 14) and low (n = 14) affiliators based on a median split of the amount of time they spent affiliating during the baseline phase of the study. During the subsequent training phase, half of the low affiliators (n = 7) were trained to increase their time spent affiliating, and half of the high affiliators (n = 7) were trained to decrease their time spent affiliating. Trained subjects were observed both during and outside of training sessions. Low affiliators significantly increased the amount of time they spent affiliating, but only during nontraining sessions. High affiliators on the other hand, significantly decreased the amount of time they spent affiliating, but only during training sessions. These data suggest that positive reinforcement techniques can be used to alter the affiliative behavior patterns of group-housed, female rhesus monkeys, although the two subgroups of subjects responded differently to the training process. Low affiliators changed their overall behavioral repertoire, while high affiliators responded to the reinforcement contingencies of training, altering their proximity patterns but not their overall behavior patterns. Thus, positive reinforcement training can be used not only as a means to promote species-typical or beneficial behavior patterns, but also as an important experimental manipulation to facilitate systematic analyses of the effects of psychosocial factors on behavior and potentially even immunology.
Descriptors: housing, animal welfare, animal training, *Macaca mulatta*, reinforcement psychology, social behavior, animal behavior.

Scott, L., P. Pearce, S. Fairhall, N. Muggleton, and J. Smith (2003). **Training nonhuman primates to cooperate with scientific procedures in applied biomedical research.** *Journal of Applied Animal Welfare Science* 6(3): 199-207. ISSN: 1088-8705.
NAL Call Number: HV4701.J68
Abstract: This report provides a brief overview of aspects of training nonhuman primates who have been, and continue to be, used in this laboratory. The research context involves applied behavioral studies in which animals are trained to perform complex operant behavioral sequences, often in their homecage environment. In such studies, animals have freedom to choose whether to engage in appetitively reinforced behavioral tests that employ neither food deprivation nor fluid management. This background of operant conditioning has provided an insight to, and a context for, animal training both as an adjunct to general laboratory management and as a way to expedite scientific procedures. Thus, training has potential implications for both well-being and scientific quality, although it must be considered an adjunct to the provision of socialization with conspecifics in high quality diverse housing systems and not as an alternative to such provision. The importance of discussion and consideration of alternative procedures cannot be overemphasized.
Descriptors: operant conditioning, positive reinforcement training, Callithrix, housing, laboratory animal husbandry, animal welfare.

Seiver, D., P. Walsh, B. Weber, and M. MacPhee. (2001). **Operant conditioning of apes to facilitate medical procedures and immobilizations**. In: *The Apes: Challenges for the 21st Century, Brookfield Zoo, May 10-13, 2000, Brookfield, IL,* Chicago Zoological Society: Chicago, Illinois, USA, p. 137-139. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACSeiver.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: apes, positive reinforcement training, animal behavior, husbandry training, immobilizations, administration of medication.

Smith, J., S. Mills, S.J. Hayes, S. Fairhall, and C. Dickson (2005). **Rhesus transportation box training protocol**. *Animal Technology and Welfare* 4(3): 153-155. ISSN: 0264-4754.
NAL Call Number: SF757 .A62
Descriptors: training program, transportation box, jump box training, laboratory animals, rhesus macaques.

Sullivan, T. (2000). **Behavioral problem solving using operant conditioning.** In: *American Zoo and Aquarium Association Regional Conference Proceedings,* American Zoo and Aquarium Association: Wheeling, West Virginia, USA, p. 167-169.
Descriptors: animal husbandry, animal behavior, using training to solve behavior problems.

Videan, E.N., J. Fritz, J. Murphy, R. Borman, H.F. Smith, and S. Howell (2005). **Training captive chimpanzees to cooperate for an anesthetic injection**. *Lab Animal* 34(5): 43-48. ISSN: 0093-7355.
NAL Call Number: QL55.A1L33
Descriptors: medical procedures, positive reinforcement training, training for injections, time investment in training animals, stress, *Pan troglodytes*, *chimps.*

Whittaker, M., G. Laule, J. Perman, S. Shapiro, and M. Keeling. (2001). **A behavioral management approach to caring for great apes**. In: *The Apes: Challenges for the 21st Century, Brookfield Zoo, May 10-13, 2000, Brookfield, IL,* Chicago Zoological Society: Chicago, Illinois, USA, p. 131-134. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/pagegen/inc/ACWhittaker.pdf
NAL Call Number: QL737.P96 A642 2001
Descriptors: great apes, enrichment, animal welfare, positive reinforcement training, captive management, behavioral management program.

Books and Conference Proceedings

AAZK Enrichment Committee (2004). ***Enrichment Notebook, 3rd Edition***, American Association of Zoo Keepers, Inc.: Topeka, Kansas, USA, ISBN: 192967211X. [CD-Rom]
NAL Call Number: SF408.45.A44 2004
Descriptors: environmental enrichment, captive exotic animals, care and husbandry, mammals, birds, reptiles and amphibians, zoo animals, bibliography.

Barnett, S.W. (2001). ***Introduction to Animal Technology***, Blackwell Science: Oxford, UK, 112 p. ISBN: 0632055944.
NAL Call Number: SF406.I58 2001
Abstract: This 112-page book details the care and use of animals in scientific research with emphasis on the Animals (Scientific Procedures) Act of 1986. The fifteen chapters include selected topics such as animal health, housing environment, routine animal house procedures, feeding and watering, breeding, physical development, experimental procedures, euthanasia, and safety. The text is written in English and indexed by subject with a glossary, tables, illustrations, and photographs, some of which are in color. Users of this book will include technicians beginning careers in animal technology and interested in pursuing certification.
Descriptors: housing conditions, breeding, laboratory animals, animals in scientific research, experimental procedures, euthanasia, handling and sexing, hygiene in research, United Kingdom.

Brent, L. (Editor) (2001). ***The Care and Management of Captive Chimpanzees***, Special Topics in Primatology, American Society of Primatologists: Chicago, Illinois, USA, 306 p. ISBN: 096583011X.
NAL Call Number: QL737.P96 C355 2001
Descriptors: animal behavior, chimps in captivity, reproductive behavior, contraception, environmental enrichment, social housing, forming social groups, legislation and regulation.

Brookfield Zoo (Compiler) (2001). ***The Apes: Challenges for the 21st Century, May 10-13, 2000, Brookfield Zoo,*** Chicago Zoological Society: Chicago, Illinois, USA, 376 p. ISBN: 0913934283.
Online: http://www.brookfieldzoo.org/content0.asp?pageID=773
NAL Call Number: QL737.P96 A642 2001
Descriptors: apes, bonobo, conservation, biodiversity, exhibit design, nutrition, husbandry, social groups.

Carbone, L. (2004). ***What Animals Want: Expertise and Advocacy in Laboratory Animal Welfare Policy***, Oxford University Press: New York, New York, USA, 291 p. ISBN: 0195161963; 0195161971 (paperback).
NAL Call Number: HV4915 .C37 2004
Descriptors: animal welfare legislation, regulations, policy, environmental enrichment, animal care, philosophy, pain, United States.

Fox, J.G., L.C. Anderson, F.M. Loew and F.W. Quimby (Editors) (2002). ***Laboratory Animal Medicine***, 2nd edition, Academic Press: New York, New York, USA, 1325 p. ISBN: 0122639510.
NAL Call Number: SF996.5 .L33 2002
Descriptors: laboratory animal medicine, legislation and regulation, health and management, animal models, diseases, design of facilities, biohazards, zoonoses, anesthesia and analgesia, animal behavior, mice, rats, hamsters, guinea pigs, rodents, rabbits, dogs, cats, ferrets, sheep, goats, cattle, pigs, amphibians, reptiles, zebrafish (*Danio rerio*), woodchucks (*Marmota monax*).

Gluck, J.P., T. DiPasquale and F.B. Orlans (2002). ***Applied Ethics in Animal Research: Philosophy, Regulation, and Laboratory Applications***, Purdue University Press: West Lafayette, Indiana, USA, 188 p. ISBN: 1557531366; 1557531374 (paperback).
NAL Call Number: HV4915 .A66 2002

Descriptors: animal experimentation, moral and ethical aspects, laboratory animals, animal welfare.

Poole, T. (Editor) (1999). ***The UFAW Handbook on the Care and Management of Laboratory Animals. Volume 1. Terrestrial Vertebrates***, 7th edition, Blackwell Science: Oxford, UK, 840 p. ISBN: 0632051329.
NAL Call Number: QL55 .U5 1999
Abstract: The new edition of this leading textbook on laboratory animals is the work of 60 contributors, and it incorporates numerous improvements in husbandry, arising from experience gained since the previous edition of 1987. The text deals with mammals (30 chapters), birds (6 chapters) and reptiles (one chapter). Each chapter describes biological features, housing, breeding, feeding and 'common welfare problems' of a given species. Thus there are 31 pages on mice, 18 on rats, 22 on guinea-pigs, and 20 on dogs. Primates are the subject of 9 chapters. Amphibians and fish are dealt with in the accompanying volume 2.
Descriptors: animal husbandry, animal housing, animal welfare, laboratory animals.

Reinhardt, V. and A. Reinhardt (2005). ***Annotated Bibliography on Refinement and Environmental Enrichment for Primates Kept in Laboratories***, 8th edition, Animal Welfare Institute: Washington, DC, USA, 89 p.
Online: http://www.awionline.org/lab_animals/biblio/index.html
NAL Call Number: HV4737 .R44 2005
Abstract: This bibliography offers animal caregivers, animal technicians, veterinarians, zoo keepers and students guidance to practical information on refinement and environmental enrichment for primates kept in research institutions.
Descriptors: bibliography on enrichment for nonhuman primates, animal welfare, species-typical behavior, abnormal behavior, social behavior and housing, positive reinforcement training, foraging and food processing behavior, safety concerns, ethics, animal welfare regulations and guidelines, animal use refinement.

Reinhardt, V. and A. Reinhardt (2001). ***Environmental Enrichment for Caged Rhesus Macaques: A Photographic Documentation and Literature Review***, 2nd edition, Animal Welfare Institute: Washington, DC, 77 p.
Online: http://www.awionline.org/lab%5Fanimals/rhesus/photo.htm
NAL Call Number: HV4737.R45 2001
Descriptors: primates as laboratory animals, rhesus macaques, *Macaca mulatta*, environmental enrichment techniques, photographs, housing and handling methods, social housing, wood sticks.

Stark, B. (Editor) (1999). ***Enrichment Notebook*, 2nd edition**, American Association of Zoo Keepers-Enrichment Committee: Topeka, Kansas, USA, ISBN: 1929672039. [Loose Leaf]
NAL Call Number: SF408.45 .A44 1999
Descriptors: zoo animals, environmental enrichment, handbooks, feeding and feeds, species-specific enrichment ideas and guidelines, birds, mammals, reptiles and amphibians.

Wolfensohn, S. and P. Honess (2005). ***Handbook of Primate Husbandry and Welfare***, 1st edition, Blackwell Publishing: Ames, Iowa, USA, 168 p. ISBN: 1405111585.
NAL Call Number: SF407.P7 W66 2005
Descriptors: primate characteristics, housing design, environmental enrichment, husbandry and management, nutrition, psychological well-bring, group housing systems, reproduction, transportation, physical well-being, primates as laboratory animals, captive wild animals, animal welfare.

Young, R.J. (2003). ***Environmental Enrichment for Captive Animals***, Universities Federation for Animal Welfare: Wheathampstead, UK, 228 p. ISBN: 0632064072.
Descriptors: animal welfare, zoo animals, animal behavior, enrichment programs, designing enrichment devices, social environment, housing, enrichment resources.

Web Site Information

Online Resources

Animal Welfare Institute, Laboratory Animals Section.
Online: http://www.awionline.org/Lab_animals/
Description: The lab animals section of the AWI website contains full-text articles about primate cage space, lighting, manipulanda, and social housing largely written by primatologist Viktor Reinhardt. The site includes a number of reference publications by Viktor and Annie Reinhardt including multiple online databases.

Best Practice in the Accomodation and Care of Primates Used in Scientific Procedures. *Medical Research Council (MRC).*
Online: http://www.nc3rs.org.uk/downloaddoc.asp?id=92
Description: Made available online by the UK's National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), this ethics guide provides information about experimental design, accomodation and environment (including enrichment, social housing and foraging), handling and training, and veterinary care.

Catarrhine Café Cookbook. *Psychological Well being Program, Washington National Primate Research Center.*
Online: http://www.wanprc.org/wanprc/cookbook-forExternal.pdf
Description: Compiled by R. Bellanca and D. Koberstein, the cookbook contains foraging enrichment ideas originally intended for macaques and baboons but applicable for other species of non-human primates. It includes "Tricks of the Trade," recipes, and examples of enrichment items.

Chimpanzee Enrichment. *Peter Dickinson, Welsh Mountain Zoo.*
Online: http://www.aszk.org.au/Husbandry%20Manuals/Chimpanzee%20Enrichment.pdf
Description: This article is a compilation of chimpanzee enrichment ideas. It includes a checklist for enrichment items to fill in prior to providing the animals with new items and gives an example of a weekly rotation of enrichment.

Comfortable Quarters for Nonhuman Primates in Research Institutions. *Viktor Reinhart, Animal Welfare Institute.*
Online: http://www.awionline.org/pubs/cq02/Cq-prim.html
Description: Published by the Animal Welfare Institute, *Comfortable Quarters* offers suggestions and recommendations about how husbandry-related variables can be minimized or avoided thereby maximizing the animals' well-being and reducing the number of subjects required to obtain reliable research data.

Disney's Animal Kingdom Theme Park ® Animal Enrichment Program Course.
Online: http://www.animalenrichment.org/
Description: Provides information about the enrichment framework used to devise enrichment programs for animals at the Animal Kingdom. Includes an introduction to enrichment and steps to set up and evaluate an enrichment program.

Disney's Animal Kingdom Theme Park ® Animal Training Program Course.
Online: http://www.animaltraining.org/
Description: Provides information about the framework used to train animals at the Animal Kingdom. The web site provides information on learning theory and training terminology; working within an animal's current facility, species natural history, and individual background; and the process of creating a training program, from setting goals to implementation and evaluation.

Enrichment for Nonhuman Primates. *National Institutes of Health, Office of Laboratory Animal Welfare.*
Online: http://grants.nih.gov/grants/olaw/Enrichment_for_Nonhuman_Primates.pdf
Description: This is a set of six booklets providing an overview of behavior and enrichment for baboons, capuchins, chimpanzees, macaques, marmosets and tamarins, and squirrel monkeys commonly used in research, education and entertainment. You may request a hard copy of any of the booklets, by emailing the NIH, Office of Laboratory Animal Welfare (OLAW) at olaw@od.nih.gov.

Enrichment Online. *The Forth Worth Zoo.*
Online: http://www.enrichmentonline.org/browse/index.asp
Description: Provided by The Fort Worth Zoo, in conjunction with the American Institute of Biological Sciences for use in zoo as well as laboratory settings. The key component of the site is a search engine for taxa-specific enrichment ideas. In addition to accommodating detailed searches for enrichment ideas, the database is interactive and allows users to input their own ideas and to also provide comments on items already in the database.

Environmental Enrichment for Caged Macaques: A Photographic Documentation. *Viktor and Annie Reinhardt, Animal Welfare Institute.*
Online: http://www.awionline.org/lab_animals/rhesus/Photo.htm
Description: A walk-through electronic slideshow developed by Viktor Reinhardt and David Seelig containing 60 photographs of enrichment techniques for laboratory rhesus macaques. Sections are divided into Animate Environmental Enrichment and Inanimate Environmental Enrichment. The publication is also available as a book. To request a free copy, send an e-mail to: viktorawi@yahoo.com.

Environmental Enrichment for Captive Animals. *American Association of Zoo Keepers (AAZK).*
Online: http://www.aazk.org/aazknew/committees/enrichment/comm_enrichment_title.asp
Description: AAZK's Enrichment Committee (http://www.aazk.org/aazknew/committees/enrichment/comm_enrichment_title.asp) provides "animal caregivers the means in which to enrich, stimulate, and challenge the lives of the animals in their care." The committee augments the "Enrichment Options" column in the Animal Keepers' Forum and in The Shape of Enrichment newsletter to provide a means for communicating ideas, techniques and information about enrichment. The website provides definitions, information about health and safety concerns, printed resources, the enrichment video library, suggested guidelines for enrichment, and links to useful web sites.

Environmental Enrichment for Lorises and Pottos.
Online: http://www.loris-conservation.org/database/Enrichment/Enrichment.html
Description: This site provides basic information on biology and behavior and details enrichment methods intended to promote specific behaviors.

Great Ape Trust of Iowa.
Online: http://www.iowagreatapes.org/index.php
Description: This research center is dedicated to providing sanctuary for great apes, studying the intelligence of great apes, advancing conservation of great apes and providing unique educational experiences about great apes. Formerly known as the Iowa Primate Learning Sanctuary.

International Directory of Primatology.
Online: http://pin.primate.wisc.edu/idp/
Description: A directory of the field of primatology including detailed information about organizations, field studies, population management, people active in primatology, and information resources. The online directory is searchable and available at the above website.

IPS International Guidelines for the Aquisition, Care and Breeding of Nonhuman Primates 2006.
International Primatological Society.
Online: http://pin.primate.wisc.edu/ips/IPSGuidelinesRevisedDRAFT.DOC
Description: These guidelines, prepared by the Captive Care and Breeding Committee, aim to promote good practice in the acquisition, care and breeding of primates and the enhancement of welfare.

Laboratory Primate Newsletter.
Online: http://www.brown.edu/Research/Primate/
Contact Information:
Psychology Department, Box 1853, Brown University, Providence, Rhode Island 02912 USA
Tel: (401) 863-2511; Fax: (401) 863-1300
E-mail: primate@brown.edu
Description: The quarterly newsletter provides information of interest to people involved in nonhuman primate research. A Directory of Graduate Programs in Primatology and Primate Research is issued periodically. The newsletter is available by e-mail or on the web. To subscribe, send the message: Subscribe LPN-L your-own-name to listserv@listserv.brown.edu. The website contains all issues of Laboratory Primate Newsletter, policies, graduate programs, and related links. The site also contains a very useful environmental enrichment section called *Articles on Environmental Enrichment and Psychological Well-being* which contains all articles on environmental enrichment and psychological well-being that were printed in the newsletter from 1984-2003. The site topics are social enrichment, environmental enrichment, training, physiological and other measures of stress and psychological well-being, rearing and social development, colony management, editorials, and information resources. Articles are available full text and free of charge.

Practical Enrichment Options for Animals Kept in Research Institutions.
Online: http://www.awionline.org/lab_animals/LAREF/enriop.htm
Description: A searchable database of enrichment ideas and practical tips collected from the Laboratory Animal Refinement and Enrichment Forum (LAREF) and other published information.

Primate Info Net (PIN).
Online: http://pin.primate.wisc.edu/
Description: PIN is a comprehensive website relating to all aspects of primatology maintained by the Wisconsin Primate Research Center (WPRC) Library (http://library.primate.wisc.edu/) at the University of Wisconsin, Madison. The website includes information services, organizations and programs, information resources, products and services for primates, and related sites.

Primate Resource Referral Service (PRRS).
Online: http://www.wanprc.org/prrs/
Contact Information:
Primate Resource Referral Service, Washington National Primate Research Center, Box 357330
University of Washington, Seattle, Washington 98195-7330 USA
Tel: (206) 543-5178; Fax: (206) 616-1710
E-mail: prrs@bart.rprc.washington.edu
Description: The PRRS provides communication between research institutions to facilitate exchanges of nonhuman primates or their tissues. The goal of the PRRS is to increase sharing of these animals, thereby decreasing the need to import animals for research, and to ultimately decrease the number of animals needed. The PRRS maintains a database of information about programs, sources, services, available/wanted animals, tissues, and primate equipment.

PrimateLit.
Online: http://primatelit.library.wisc.edu/
Contact Information:
Library and Information Service, Wisconsin Primate Research Center University of Wisconsin
1220 Capitol Court Madison Wisconsin 53715 USA

Tel: (608) 263-3512;
E-mail: library@primate.wisc.edu
Description: PrimateLit is a bibliographical database for primatology and exists through a cooperative agreement between the Washington (WaNRPC) and Wisconsin (WRPC) National Primate Research Centers. The WPRC coordinates the project with technical support from the University of Wisconsin-Madison's Library Technology Group. Literature acquisition, analysis, and indexing are carried out by the *Primate Information Center* at the WaNRPC, University of Washington. The database, which is updated twice a month and contains records dating from 1940, allows primate researchers to do their bibliographic research on their home or office computers.

The Shape of Enrichment.
Online: http://www.enrichment.org
Description: A nonprofit corporation with aims to further environmental enrichment efforts worldwide. A quarterly publication called *The Shape of Enrichment* provides an open forum to exchange enrichment ideas among animal professionals. There is also an enrichment and training video library maintained in conjunction with the American Association of Zoo Keepers. Finally, the bi-annual International Conference on Environmental Enrichment is promoted on the Web site.

Teaching Materials - American Society of Primatologists.
Online: http://www.asp.org/education/teaching.html
Description: Provides links to resources for people interested in learning more about nonhuman primates, or for teachers who would like to teach about primates in their classroom.

Training Laboratory-Housed Nonhuman Primates: A Survey of Current Practice in the UK.
Prescott, M. J. and Buchanan Smith, H. M.
Online: http://www.nc3rs.org.uk/downloaddoc.asp?id=215
Description: This is a powerpoint presentation that presents an overview of the literature about training nonhuman primates to cooperate in the laboratory environment. It also provides data from a questionnaire about the current status of training in UK facilities.

The Welfare of Non-human Primates Used in Research, Report of the Scientific Committee on Animal Health and Animal Welfare.
Online: http://www.aisal.org/pages/doc_vari/out83_en.pdf
Description: A report prepared for the European Union (EU) Commission about the welfare of non-human primates used for experiments, adopted on December 17, 2002. Includes information about various enrichment aspects such as social housing, animal training, and provision of visual barriers.

Organizations and Professional Societies

American Association of Zoo Keepers (AAZK).

Online: http://www.aazk.org

Contact Information:

3601 SW 29th Street, Suite 133, Topeka, Kansas 66614-2054 USA

Description: AAZK is an organization made up of professional zoo keepers and other people dedicated to professional animal care and conservation.

American Society of Primatologists (ASP).

Online: http://www.asp.org/

Description: The American Society of Primatologists is an educational and scientific organization whose purpose is to promote the discovery and exchange of information regarding primates, including all aspects of their anatomy, behavior, development, ecology, evolution, genetics, nutrition, physiology, reproduction, systematics, conservation, husbandry, and use in biomedical research. The society publishes the *American Journal of Primatology*, a quarterly bulletin for members, and the book *Primate Conservation: The Role of Zoological Parks* (J. Wallis, ed., 1997).

Association of Zoos and Aquariums (AZA).

Online: http://www.aza.org

Contact Information:

8403 Colesville Road, Suite 710, Silver Spring, Maryland 20910-3314 USA

Tel: (301) 562-0777; Fax: (301) 562-0888

Description: Formerly called the American Zoo and Aquarium Association, AZA is a nonprofit organization dedicated to the advancement of zoos and aquariums in the areas of conservation, education, science, and recreation. The AZA Office of Conservation and Science coordinates Taxon Advisory Groups (TAG) which monitor the status of particular species in captivity and provide recommendations on species management in captivity and with respect to conservation efforts. Primate TAGs include gibbons, great apes, New World monkeys, Old World monkeys, and prosimians. Committees, such as the Behavior and Husbandry Advisory Committee, specialize in broad scientific areas and are coordinated to serve in advisory capacities for TAGs. The AZA holds regional and annual conferences at which environmental enrichment at zoos is often discussed. Services are geared towards member institutions, but anyone may contact members of these groups for information. There are fees for AZA membership, published membership directories, reports, and conference proceedings.

The Animal Behavior Management Alliance (ABMA).

Online: http://www.theabma.org/

Description: An organization of animal care professionals interested in enhancing animal care through training and enrichment. Information is disseminated to members through a quarterly newsletter called *Wellspring* and annual conferences.

Association of British Wild Animal Keepers (ABWAK).

Online: http://www.abwak.co.uk/

Description: ABWAK is a non-profit organization specializing in improving cooperation among wild animal keepers. The site has links to information about the journal Ratel, animal diets, husbandry, grants, and job openings. A publication called *Guidelines for Environmental Enrichment* can be purchased through the website.

Association of Primate Veterinarians (APV).

Online: http://www.primatevets.org

Description: The members of the APV are veterinarians working with nonhuman primates in zoos and research settings as well as breeders. The Publications page of the web site contains a link to the *Primate Formulary*, compiled by D. Rick Lee and C.J. Doane, in Microsoft Excel format.

Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART): Australia office.

Online: http://www.adelaide.edu.au/ANZCCART/

Contact Information:

The Director, B03 Mitchell Building, Adelaide University, South Australia 5005 Australia
Tel: 61-8-8303 7586; Fax: 61-8-8303 7587
E-mail: anzccart@adelaide.edu.au

Description: Through its varied activities, ANZCCART seeks to promote effective communication and cooperation between all those concerned with the care and use of animals in research and teaching. It publishes a quarterly newsletter and other publications on topics such as euthanasia, animal care and use committees, humane care and use of animals in research, and pain. Articles sometimes address environmental enrichment issues.

Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART): New Zealand office.

Online: http://www.rsnz.org/advisory/anzccart/

Contact Information:

The Executive Officer, C The Royal Society of New Zealand, PO Box 598, Wellington, New Zealand
Tel: 64-4-472 7421; Fax: 64-4-473 1841
E-mail: anzccart@rsnz.org

Description: Through its varied activities, ANZCCART seeks to promote effective communication and cooperation between all those concerned with the care and use of animals in research and teaching. It publishes a quarterly newsletter and other publications on topics such as euthanasia, animal care and use committees, humane care and use of animals in research, and pain. Articles sometimes address environmental enrichment issues.

Canadian Council on Animal Care (CCAC).

Online: http://www.ccac.ca/

Contact Information:

Suite 1510 - 130 Albert Street, Ottawa, Ontario K1P 5G4 Canada
Tel: (613) 238-4031; Fax: (613) 238-2837
E-mail: ccac@ccac.ca

Description: CCAC establishes and enforces standards and guidelines (in Canada) concerning the use of animals in research, testing and teaching. Maintains active, expert committees on all aspects of animal care and use. The Council's program is based on its major publication "Guide to the Care and Use of Experimental Animals," Volume 1, 2nd Edition (1993) and Volume 2 (1984). Both documents address environmental enrichment. CCAC conducts workshops and training courses on various aspects of the care and use of experimental animals, as well as the training of personnel working with these animals. Semi-annually publishes the newsletter, *Resource*. Training module No. 7 is about environmental enrichment (http://www.ccac.ca/en/CCAC_Programs/ETCC/Module10E/TableofContentsModule10.htm).

European Federation for Primatology (EFP).

Online: http://www.unipv.it/webbio/efp/efp.htm

Description: The EFP brings together national primatological societies as well as groups of primatologists in those countries of Europe where societies could not yet be founded. It coordinates activities between different European societies and promotes the management and study of nonhuman primates. The EFP newsletter is published in the journal *Folia Primatologica*.

European Marmoset Research Group (EMRG).

Online: http://www.emrg.org

Contact Information:

Christopher Pryce, Behavioural Neurobiology Laboratory, Swiss Federal Institute of Technology, Zurich, Schorenstr. 16 CH-8603 Schwerzenbach Switzerland
Tel: +41 (0) 1 655 7386; Fax: +41 (0) 1 655 7203
E-mail: pryce@behav.biol.ethz.ch

Description: The EMRG is a nonprofit organization that aims to facilitate communication exchange between academic and industrial institutions conducting biological and/or biomedical research using nonhuman primates with a specific goal of optimizing the use of marmosets and tamarins. The group publishes a biannual newsletter and organizes workshops. It also published the 1997 *Handbook of Marmosets and Tamarins in Biological and Biomedical Research.*

Institute for Laboratory Animal Research (ILAR).

Online: http://dels.nas.edu/ilar_n/ilarhome/

Contact Information:

The National Academies, 500 Fifth Street NW, Keck 687, Washington, DC 20001 USA
Tel: 202-334-2590; Fax: 202-334-1687
E-mail: ILAR@nas.edu

Description: ILAR is a program unit in The Division on Earth and Life Studies (DELS) of the National Academies. It develops guidelines and disseminates information on the scientific, technological, and ethical use of animals and related biological resources in research, testing, and education. ILAR promotes high-quality, humane care of animals and the appropriate use of animals and alternatives. ILAR functions within the mission of the National Academy of Sciences as an advisor to the federal government, the biomedical research community, and the public. ILAR spearheaded the committee which produced the 1998 book *The Psychological Well-being of Nonhuman Primates.*

International Primatological Society (IPS).

Online: http://pin.primate.wisc.edu/ips/

Description: The society facilitates cooperation among primatologists and fosters conservation and the judicious use of primates in research. Environmental enrichment issues are addressed by the Captive Care and Breeding Committee. IPS operates a small grants program for education and enrichment studies that have broad implications. The grants program is open to all applicants.

Office of Laboratory Animal Welfare (OLAW).

Online: http://grants.nih.gov/grants/olaw/olaw.htm

Contact Information:

National Institutes of Health, Office of Extramural Research, OLAW Division of Animal Welfare, 6100 Executive Blvd., Suite B01, Rockville, Maryland 20892-7507 USA
Tel: (301) 496-7163; Fax: (301) 402-2803
E-mail: olaw@od.nih.gov

Description: Located at the National Institutes of Health, Office of Extramural Research, OLAW enforces the PHS Policy on Humane Care and Use of Laboratory Animals for researchers who receive Public Health Service funding. Produces conferences and workshops relating to responsible animal care and use in biomedical research. OLAW can provide guidance on the development of plans to enhance psychological well-being of nonhuman primates. The PHS Policy requires adherence to the Animal Welfare Act regulations and the Guide for the Care and Use of Laboratory Animals.

Primate Society of Great Britain (PSGB).

Online: http://www.psgb.org/

E-mail: info@psgb.org

Description: PSGB is a membership organization affiliated with the International Primatological Society. It has a Conservation Working Party and Captive Care Working Party to provide advice

and coordinate action. Sponsors an annual meeting and publishes triennial *Primate Eye*.

Scientists Center for Animal Welfare (SCAW).
Online: http://www.scaw.com/
Contact Information:
7833 Walker Drive, Suite 410, Greenbelt, Maryland 20770 USA
Tel: (301) 345-3500; Fax: (301) 345-3503
E-mail: info@scaw.com
Description: A professional, non-profit organization that sponsors conferences addressing contemporary animal care and use issues in research. Publishes conference proceedings, training manuals, and newsletters. Publications include *Well-Being of Nonhuman Primates in Research* and other SCAW-sponsored conference proceedings. Anyone may request membership, attend conferences, or purchase publications.

Universities Federation for Animal Welfare (UFAW).
Online: http://www.ufaw.org.uk/
Contact Information:
The Old School, Brewhouse Hill, Wheathampstead, Hertfordshire AL4 8AN United Kingdom
Tel: +44 (0)1582 831818; Fax: +44 (0)1582 831414
E-mail: ufaw@ufaw.org.uk
Description: UFAW is a scientific and technical animal welfare organization. It uses scientific knowledge and established expertise to improve the welfare of animals as pets, in zoos, laboratories, on farms and in the wild. UFAW does not campaign but funds research, holds symposia, gives advice to Government and others and produces publications on animal welfare.

US Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Office of Animal Care (AC).
Online: http://www.aphis.usda.gov/ac/
Contact Information:
Headquarters, 4700 River Road, Unit 84, Riverdale, Maryland 20737-1234 USA
Tel: (301) 734-7833; Fax: (301) 734-4978
E-mail: ace@aphis.usda.gov
Description: The U.S. Department of Agriculture office that enforces the Animal Welfare Act and develops animal care regulations for exhibitors, researchers, and animal dealers. APHIS/AC answers questions regarding the regulations including those about the psychological well-being of nonhuman primates. The staff also refers patrons to regional offices where they can communicate directly with Animal Care inspectors and veterinary medical officers.

U.S. National Primate Centers

National Primate Research Centers.

Online: http://www.ncrr.nih.gov/compmed/cm_nprc.asp

Description: National Primate Research Centers (NPRCs) are a group of eight highly specialized facilities for research using nonhuman primates (NHP). The centers are funded by grants through the National Institutes of Health (NIH), National Center for Research Resources (NCRR), Division of Comparative Medicine (DCM). Staffed with experienced research and support personnel, each center provides the appropriate research environment to foster the development of NHP models of human health and disease for biomedical investigations. The NPRCs are affiliated with academic institutions and are accessible to eligible biomedical and behavioral investigators supported by research project grants from the NIH and other sources. The National Primate Research Centers were formerly called Regional Primate Research Centers. The name was changed in April 2002 to reflect the expanded role of the centers.

California National Primate Research Center.

Online: http://www.cnprc.ucdavis.edu/

Contact Information:

University of California, Davis, One Shields Avenue, Davis, California 95616-8542 USA
Tel: (530) 752-0447; Fax: (530) 752-2880
E-mail: web_cnprc@primate.ucdavis.edu

Description: Research emphasizes the effects of environmental influences on human health and basic biological approaches. Resources provided include medicine, pathology and clinical laboratory services, electron microscopy, inhalation toxicology chambers, colony database, animals from breeding and research colonies, research facilities and pathological specimens for collaborators.

New England Primate Research Center.

Online: http://www.hms.harvard.edu/nerprc/

Contact Information:

One Pine Hill Dr., PO Box 9102, Southborough, Massachusetts 01772 USA
Tel: (508) 524-8002; Fax: (508) 460-0612
E-mail: neprc@hms.harvard.edu

Description: Research emphasis is on infectious diseases, immunology, oncological herpesviruses, pathology, behavioral biology, and cardiovascular disease. Provides tissues and other specimens for approved research projects as well as animals from breeding colonies.

Oregon National Primate Research Center.

Online: http://onprc.ohsu.edu/

Contact Information:

Oregon Health & Science University, 505 N. W. 185th Avenue, Beaverton, Oregon 97006-3448 USA
Tel: (503) 645-1141

Description: Scientists at the Oregon National Primate Research Center conduct basic and applied biomedical research in three priority areas identified for improving human health and well-being: (1) fertility control, early embryo development and women's health; (2) brain development and degeneration; and (3) newly emerging viruses, especially AIDS-related agents.

Southwest National Primate Research Center.

Online: http://www.sfbr.org/pages/snprc_index.php

Contact Information:

P.O. Box 760549, San Antonio, Texas 78245-0549 USA

Tel: (210) 258-9400
E-mail: stardif@sfbr.org
Description: Research focus on nonhuman primate models of human diseases, including common chronic diseases and infectious diseases, genetic and environmental effects on physiological processes, and susceptibility to specific diseases. Located on the campus of the Southwest Foundation for Biomedical Research (http://www.sfbr.org).

Tulane National Primate Research Center.
Online: http://www.tpc.tulane.edu/
Contact Information:
18703 Three Rivers Road, Covington, Louisiana 70433 USA
Tel: (504) 892-2040; Fax: (504) 893-1352
E-mail: info@tpc.tulane.edu
Description: Specializes in research in microbiology, parasitology, urology, gene therapy, and behavior. Provides laparoscopy, ultrasound, and specimens. Collaborating scientists receive animal care, pathology services, parasitology services, science information ser vices, medical illustration services, and animals.

Wisconsin Primate Research Center.
Online: http://www.primate.wisc.edu/
Contact Information:
1220 Capitol Court, Madison, Wisconsin 53715-1299 USA
Tel: (608) 263-3500; Fax: (608) 265-2067
E-mail: jlenon@primate.wisc.edu
Description: Research emphasizes reproduction and development, neurobiology, physiological ethology, psychobiology, aging and metabolic disease, and immunology and virology. Outside investigators may request biological materials. Collaborating scientists receive many bioservices, computer services, and animals.

Yerkes National Primate Research Center.
Online: http://www.yerkes.emory.edu/
Contact Information:
Office of Public Affairs, 954 Gatewood Road, Atlanta, Georgia 30322 USA
Tel: (404) 727-7732; Fax: (404) 727-3108
E-mail: yerkes-information@rmy.emory.edu
Description: Research emphasis is on biomedical and biobehavioral research to improve the health and well-being of human and nonhuman primates. Animals, veterinary medicine, pathology, and biomedical engineering are provided to investigators.

Additional Primate Centers and Animal Colonies

Caribbean Primate Research Center.

Online: http://ucm.rcm.upr.edu/cprc.html

Contact Information:

Dr. Edmundo Kraiselburd, Director, Caribbean Primate Research Center, PO Box 1053, Sabana Seca, Puerto Rico 00952

Tel: (787) 784-0322, 795-4035; Fax: (787) 795-6700

E-mail: ekraiselburd@rcm.upr.edu

Description: Supported by a core grant from the National Institutes of Health (NIH), National Center for Research Resources (NCRR), and the University of Puerto Rico. Consists of three facilities: (1) the free-ranging island colony of rhesus monkeys on Cayo Santiago which is used primarily for behavioral, demographic, genetics and noninvasive types of biomedical research, (2) the Sabana Seca Field Station, an NIH-owned facility, which houses rhesus monkeys derived from the Cayo Santiago colony in various outdoor configurations for behavioral and biomedical studies, and (3) the CPRC Museum, located at the School of Medicine on the Medical Sciences Campus, which contains the CPRC Skeletal Collection, one of the world's largest collections of complete nonhuman primate skeletons for anatomical, anthropological and biomedical research.

Center for Neotropical Primate Research and Resources.

Online: http://www.southalabama.edu/cnprr/

Contact Information:

University of South Alabama, Mobile, Alabama 36688 USA

Tel: (251) 460-6293; Fax: (251) 460-6286

E-mail: info@smbrr.org

Description: CNPRR is a National Institutes of Health sponsored laboratory to study and provide information about squirrel monkey reproductive biology and behavior.

Duke Lemur Center.

Online: http://primatecenter.duke.edu/

Contact Information:

Box 90385, Duke University, 3705 Erwin Road, Durham, North Carolina 27705 USA

Tel: (919)489-3364; Fax: (919)490-5394

E-mail: primate@duke.edu

Description: Research focuses on several major areas: the systematics, behavior, physiology, biomechanics and anatomy of living lemurs; husbandry practices necessary for keeping and breeding prosimians; field research involving the distribution, behavior, ecology, and conservation needs of lemurs in Madagascar; field research on habitat conservation, reintroduction of lemurs into the wild, and effectiveness of conservation education programs; and evolution of primates through the discovery, description, and analysis of living and fossil primates.

Living Links Center.

Online: http://www.emory.edu/LIVING_LINKS/

Contact Information:

Emory University, Yerkes National Primate Research Center, 954 N. Gatewood Road, Atlanta, Georgia 30322 USA

E-mail: LIVING_LINKS@emory.edu

Description: The Living Links Center for the Advanced Study of Ape and Human Evolution specializes in comparisons of the social life, ecology, cognition, neurology, and molecular genetics of four extant great apes (bonobos, chimpanzees, gorillas, and orangutans) and humans. The Center was established in 1997 at Emory University and is an integrated part of Yerkes Primate Center. The institute conducts all of its work with noninvasive techniques that they would not hesitate to apply to human volunteers. Their goals are 1) to reconstruct human evolution, 2) pinpoint the differences and similarities between humans and apes, and 3) educate

the public about apes, and promote their well-being and conservation.

New Iberia Research Center.

Online: http://nirc.louisiana.edu/

Contact Information:

4401 W. Admiral Doyle Drive, New Iberia, Louisiana 70560 USA

Tel: (337) 482-2411

E-mail: NIRCweb@louisiana.edu

Description: "The University of Louisiana at Lafayette New Iberia Research Center specializes in the breeding, management, and importation of a diverse range of nonhuman primate species and offers a broad range of diagnostic, laboratory, and human resources for the development and characterization of nonhuman primate models for applied and basic research aimed at promoting human quality of life."

Products and Suppliers

This document provides current information on environmental enrichment products and suppliers for people who are looking to acquire enrichment items for nonhuman primates in captive settings. Mention of commercial enterprises or brand names does not constitute endorsement or imply preference by the U.S. Department of Agriculture.

Absolute Primate Enrichment Systems (A.P.E.S).
Online: http://www.absoluteprimate.com/
Contact Information:
241 N. Dobson, Burleson, Texas 76028 USA
Tel: (817) 228-2283; Fax: (817) 426-4815
E-mail: lwood@absoluteprimate.com
Description: Supplier of a wide range of enrichment products including balls, feeders, chew toys, tug rings, swings, and perches. Also custom make products to fit individual environments.

Animal Specialties and Provisions.
Online: http://www.animalspecialties.biz/default.asp
Contact Information:
P.O. Box 45, Quakertown, Pennsylvania 18951 USA
Tel: (215) 804-0144 ; Fax: (215) 804-0148
E-mail: info@animalspecialties.biz
Description: Manufacturer of environmental enrichment devices for nonhuman primates, dogs, cats, rabbits, and rodents. Devices include foraging balls and trays, gnawing sticks, mirrors, and dumbbells. Also produces feeds and bedding products for numerous species.

Aussie Dog Products.
Online: http://www.aussiedog.com.au
Contact Information:
P.O. Box 308, Ferntree Gully, Victoria 3156 Australia
Tel: +61 3 9752 3336; Fax: +61 3 9758 3020
E-mail: aussiedog@aussiedog.com.au
Description: Manufacturer of purpose-built, safe, durable toys and products for all animals, especially dogs, horses, and a growing range of zoo animals including nonhuman primates.

BH, Inc.
Online: http://www.bhenrich.com/
Contact Information:
1302 9th Street, Wheatland, Wyoming 82201 USA
Tel: (307) 322-4040; Fax: (307) 322-4141
Description: Produces nonhuman primate caging that comes with Environ-Richment® Entertainment Panels that provide increased possibilities for manipulation, novel visual stimulation and foraging opportunities.

Bio-Serv.
Online: http://www.bio-serv.com
Contact Information:
One 8th Street, Suite One, Frenchtown, New Jersey 08825 USA
Tel: (908) 996-2155 OR 1-800-996-9908; Fax: (908) 996-4123
E-mail: techserv@bio-serv.com; sales@bio-serv.com
Description: Produces and distributes edible enrichment treats, enrichment devices, and custom and special needs diets for all laboratory animal species. Primate enrichment products include

balls, shake-a-treat devices, mirrors, Kong rubber toys, and other manipulanda. Most products are certified contaminant screened.

Carter$_2$ Systems, Incorporated.
Online: http://www.csimfg.com
Contact Information:
P.O. Box 6206, Beaverton, Oregon 97007 USA
Tel: 503-844-4220; 1-800-255-7553; Fax: 503-844-9508
Description: Specializes in nonhuman primate housing, transfer cages and environmental enrichment. Enrichment options include vertical tunnels, play cages, ladders, treat boxes, gym sets and ferris wheels.

Lab Products Inc.
Online: http://www.labproductsinc.com/
Contact Information:
742 Sussex Avenue, P. O. Box 639, Seaford, Delaware 19973 USA
Tel: (302) 628-4300 OR (800) 526-0469; Fax: (302) 628-4309
E-mail: info@labproductsinc.com
Description: Designs and manufactures laboratory animal housing and care equipment. Primate Enrichment System cages allow flexibility in housing options with removable panels.

The Leather Elves.
Online: http://www.theleatherelves.com/
Contact Information:
43 Mutton Lane, Weymouth, Massachusettes 02189 USA
Tel: (781) 331-8557;
E-mail: BIRDELVES@aol.com
Description: The Leather Elves makes safe and durable toys for birds. Their new zoo line includes larger toys for primates such as primate puzzles and carousel feeders.

Lomir Primate Enrichment Technologies.
Online: http://lomir.com/pet/
Contact Information:
99 East Main Street, Malone, New York 12953 USA
Tel: 1-877-425-3604; Fax: (518) 483-8195
E-mail: info@lomir.com
Description: Producers of unique primate enrichment devices made of durable opaque polypropylene. Devices are designed to increase foraging time. Also has offices in Quebec, Canada.

MyTrainingStore.com.
Online: http://www.mytrainingstore.com/
Contact Information:
215 Daffodil Road, Southern Pines, North Carolina 28387 USA
Tel: (910) 246-6263 ; Fax: (910) 692-8799
E-mail: info@mytrainingstore.com
Description: Suppliers of training supplies such as clickers, whistles, and lanyards, and distributor of Active Minds Enrichment Gear (AMEG). The toys are durable enough for all types of animals and come in unique colors and shapes. They can customize each shape according to your needs.

Nylabone Products.
Online: http://www.nylabone.com
Contact Information:
1 TFH Plaza, 3rd & Union Avenues, Neptune City, New Jersey 07753 USA
Tel: (800) 631-2188;

E-mail: info@nylabone.com
Description: Manufacturer of Nylabone, Nylaballs, Gumabone Plaque Attacker, Gumabone tugs, and Gumadisc Flying Disc chew toys for dogs and other animals, including nonhuman primates.

Otto Environmental, LLC.
Online: http://www.ottoenvironmental.com
Contact Information:
6914 N. 124th Street, Milwaukee, Wisconsin 53224 USA
Tel: (414) 358-1001; Fax: (414) 358-9035
E-mail: jeff@ottoenvironmental.com
Description: Supplier and manufacturer of enrichment products, foraging devices, caging, transport boxes, and other equipment for all species. Products manufactured by Otto Environmental include the Zoy™, Bingo Ball™, and the Hammock™. The company works closely with laboratory and zoo facilities and is the exclusive distributor of Aussie Dog Products in the USA.

Primate Products, Inc.
Online: http://www.primateproducts.com/
Contact Information:
PO Box 620415, Woodside, California 94062 USA
Tel: (650) 529-0419; Fax: (650) 851-1763
E-mail: corporate@primateproducts.com
Description: Supplier of "Kong Toys" which are autoclavable hollow toys that are durable enough to withstand rough handling and biting. They can also be filled with treats. Also manufactures mirrors, puzzle and nutra-toss foraging devices, and primahedrons

Sanctuary Supplies.
Online: http://www.sanctuarysupplies.com/
Tel: (877) 886-1992
E-mail: kathy@sanctuarysupplies.com
Description: Supplier of hard to find supplies needed by animal sanctuaries, zoos, rescues, and shelters. Products include enrichment devices, cleaning items, and housing supplies for all animal species.

Steiner Enterprises, Inc.
Online: http://www.steineronline.com/
Contact Information:
2780 Conservation Club Road, Lafayette, Indiana 47905 USA
Tel: (765) 429-6409; Fax: (765)429-5795
Description: Manufactures enrichment products for nonhuman primates including foraging balls, foraging ball loaders, tube style foraging feeders, primate perches, biscuit feeders, and rattles. Custom designs are also accepted and manufactured.

Online Discussion Groups

Alloprimate.

Online: http://groups.yahoo.com/group/alloprimate
Description: A moderated general primatology site that focuses on primate conservation, ecology, research, environmental enrichment, health and disease, ethology/behavior, and sanctuary/zoo operations.

Laboratory Animal Refinement and Enrichment Forum (LAREF).

Online: http://www.awionline.org/lab_animals/index.htm
Description: Moderated by Viktor Reinhardt of the Animal Welfare Institute, LAREF facilitates the exchange of experiences about ways to improve the conditions under which laboratory animals are housed and handled. The group is intended to serve the international animal care community in its attempt to promote animal welfare and improve scientific methodology by avoiding or eliminating husbandry-related stress situations. The forum is open to animal care personnel, animal technicians, students, attending veterinarians and researchers who have or had first-hand experience in the care of animals kept in laboratories. If you want to join the group please send a message to viktorawi@yahoo.com indicating your name, professional affiliation, professional experience, and professional interest.

Primate Enrichment Forum (PEF).

Online: http://pin.primate.wisc.edu/infoserv/forums/pef/pefentry.html
Description: An email list designed to facilitate communication between professionals working at primate biomedical research facilities on environment enrichment topics, stress, well-being, and husbandry. The list is open to animal caretakers, veterinary, research, and behavioral technicians, veterinarians, colony managers, research scientists, and behaviorists/enrichment coordinators. In order to be added to the list, you must submit an online application.

Primate-News (P-News).

Online: http://pin.primate.wisc.edu/infoserv/forums/pnews/
Description: Delivers selected Web-based news clippings and announcements about nonhuman primates via email on a semi-regular basis. Access to some news articles may require registration at the particular publication's Web site. Subscribers cannot post messages to the list. Managed by the Wisconsin National Primate Center.

Primate-Science.

Online: http://pin.primate.wisc.edu/infoserv/forums/ps/
Description: An e-mail list managed by the Wisconsin Primate Research Center. It is open worldwide to staff at nonhuman primate centers and laboratories and those conducting primate research in academic institutions or zoos. The purpose of this forum is the factual, science-based exchange of ideas and information about nonhuman primates and is intended to serve the international primatological research community. In order to be added to the list, you must submit an online application.

USDA Final Report and Draft Policy

Final Report on Environmental Enhancement to Promote the Psychological Well-being of Nonhuman Primates

U. S. Department of Agriculture
Animal and Plant Health Inspection Service
Animal Care
Riverdale, MD
July 15, 1999

This Final Report contains the scientific basis for the Draft Policy and the methods USDA, APHIS, Animal Care used in developing the Draft Policy.

To view the Draft Policy and request for comments that was published in the Federal Register on July 15, 1999, see pages 231-236 of this document.

NOTE: This document is accessible on the web at: http://www.aphis.usda.gov/ac/eejuly15.html. The Draft Policy is also available on the web at: http://www.aphis.usda.gov/ac/ee.html (text) or http://www.aphis.usda.gov/ac/ee.pdf (PDF).

Table of Contents

I. INTRODUCTION AND PROJECT HISTORY

This report provides Animal and Plant Health Inspection Service (APHIS) Animal Care employees, the facilities they regulate, and the public with a policy on environment enhancement to promote the psychological well-being of nonhuman primates. The policy is an interpretation of the regulation published in 9 CFR, Part 3, Subpart D, §3.81. This report explains the scientific basis for the policy and how it was developed. It consists of the following:

- **Chapter I. Introduction and Project History**
  Reviews background of the project to develop the policy: how it was initiated, the methods used, and the results of surveys and interviews.

- **Chapter II. Promoting Psychological Well-Being**
  Explains the Animal Welfare Act, the language of U.S. regulatory standards, other nations' requirements regarding primates' psychological needs, the difficulties inherent in measuring psychological well-being, and the reason why this policy relies on species-typical noninjurious behavior as the primary indicator of psychological well-being.

- **Chapter III. Critical Element Concept**
  Introduces the concept of categories of primate behavioral needs and explains that there are environment enhancement strategies or elements that correspond to each. Gives the critical elements to be addressed in each environment enhancement plan for captive primates.

- **Chapter IV. Literature Review and Discussion**
  Reviews the professional literature applicable to meeting the psychological needs of captive primates. Presents the findings for each critical element and additional considerations.

- **Chapter V. References**
  Lists bibliographic references used in the literature review.

- **Appendix A. 9 CFR Section 3.81 Environment Enhancement to Promote the Psychological Well-Being of Nonhuman Primates**
  Shows the relevant regulation of USDA.

- **Appendix B. Species Information Sheets**
  Shows facts about primate species commonly found in U.S. facilities. Includes how they live in the wild and suggests options or strategies for each critical element.

- **Appendix C. Glossary**
  Defines special terms frequently used in this report.

A. Background on Evaluation of the Performance-Based Standard for Nonhuman Primates

Performance-based standards in Animal Care have been controversial since their inclusion in the 1985 Amendments to the Animal Welfare Act.[1] In 1991, when USDA, APHIS adopted Title 9 of the Code of Federal Regulations (CFR), Part 3, Subpart D, "Specifications for the Humane Handling, Care, Treatment, and Transportation of Nonhuman Primates", it included Section §3.81 called, "Environment enhancement to promote psychological well-being of nonhuman primates." (See Appendix A for the text.) After about five years, APHIS conducted an internal evaluation[2] of the performance-based standards. It administered a brief mail survey of its Animal Care field

employees about their opinions and experiences applying these standards. The survey results indicated a number of concerns regarding the effectiveness of the standards for environment enhancement of nonhuman primates.

Many of the opinions expressed by Animal Care employees in the 1996 survey centered around a lack of clarity and specificity in the standards and a perceived lack of enforceability. Almost half the responding employees felt that the criteria in the regulations were not adequate for facilities to understand how to meet them and for inspectors to judge if a facility was in compliance. About two thirds of the responding employees suggested additional criteria or items that should be in a facility's primate enhancement plan. Twelve employees proposed some specific requirements on social grouping, primary enclosure space, foraging opportunities, novelty, or other environmental features.

The 1996 study report offered some recommendations on how to improve the effectiveness of the standards, including:

- Guidelines should be developed by Animal Care to clarify and provide more structure to the existing standards; and
- Documentation should be required of facilities to demonstrate continued effectiveness of their primate enhancement plans.

As a result of these recommendations, APHIS's Animal Care Management Team assigned a team of Animal Care field employees to develop a model for primate environment enhancement and a policy for inspectors and facilities. Their goal was to retain the performance-based approach, and maintain a balance between the Agency's need for inspection practicality and enforceability and its need for flexibility and results-orientation. It is hoped that the interpretive policy developed as a result of this team's work will assist in the fair application and enforcement of the environment enhancement standard.

B. Team Methods

APHIS Animal Care's Primate Environment Enhancement Team was formed in March, 1997. It was composed of five Veterinary Medical Officers, an Animal Care Inspector, a Regional Director, a resource specialist from USDA's National Agricultural Library's Animal Welfare Information Center, the coordinator of APHIS Animal Care's Strategic Direction initiative, and an anthropologist from APHIS's Policy and Program Development. They are, alphabetically, Tim Allen, Ruth Bakker, Lisa Bellamy, Charlie Currer, Greg Gaj, Betty Goldentyer, Betsy Lyons, Natalie Roberts, Sylvia Taylor, and Dick Watkins.

From March 1997 to March 1998, the Enhancement Team embarked on an extensive review of the professional primatology literature, a number of facility primate enhancement plans, and some enforcement case histories. Comments made by employees in the 1996 mail survey were reviewed. A number of respected professionals, knowledgeable about primates, were consulted.

During the early phase of the project, members of the Primate Environment Enhancement Team needed to understand their colleagues' opinions more clearly and in more detail than could be derived from the 1996 employee survey data. To supplement the information collected, the team members contacted 21 other Animal Care field employees who inspect primate facilities. They interviewed them regarding current conditions at the facilities they inspect that house primates. They asked what the problems are and what should be required of facilities to improve the care of primates. These in-depth interviews revealed that certain inadequate environment enhancement conditions and practices persist at regulated facilities although the 1985 amendments to the Animal Welfare Act were intended to minimize these conditions or practices. The inspectors echoed many sentiments expressed in the 1996 mail survey and called for guidance that would

provide more structure and specificity and clarify the minimum quantity and quality of enrichment that will be enforceable.

In a series of conference calls and meetings, the Primate Environment Enhancement Team developed a conceptual model and a policy. Members also drafted this discussion and the supplementary materials shown in the appendices that are intended to aid inspectors and regulated parties. The Enhancement Team members circulated the draft materials for comment and revision to colleagues at the Animal Care Employees National Work Conference in Riverdale, Maryland in March 1998, and to the Supervisory Animal Care Specialists and Animal Care Staff in August, 1998. The team tested the application of the proposed policy by visiting four facilities, and as a result, made several modifications to the policy.

In preparation for the document's release to the public for comment, it was reviewed by several members of USDA management and federal partners. Modifications were made to ensure the policy's enforceability and consistency with other policies and the report's readability and proper form. A decision was made to call the new document a "policy" rather than "guidelines", as it had been referred to up to this point. The accompanying *Federal Register* documents were developed.

The Team would like to acknowledge and thank many people who have contributed to the development of this document so far. Researchers, librarians, and consultants have provided copies of publications. Facilities, associations, and animal interest groups have provided background information and expressed their opinions. APHIS Animal Care inspectors and Supervisory Animal Care Specialists have reviewed earlier drafts and provided feedback. They facilitated the field visits. Other staff members in Headquarters have facilitated the clearance of the policy, assisted with production, distribution, and communications. USDA's National Agricultural Library has provided editorial advice. In particular we would like to thank: Janet Baer, Kate Baker, Mollie Bloomsmith, Sue Boinski, Linda Brent, Cobie Brinkman, Allegra Bukojemsky, John Cant, Douglas Cohn, Debra Forthman, Nelson L. Garnett, Marisa Garza Schmidt, Larry Jacobsen, Michael D. Kreger, Jean A. Larson, Barbara Lester, Trevor Poole, Viktor Reinhardt, David Seelig, and Lucy Lerner Wormser. While these individuals were very helpful in providing their input, they are in no way responsible for the text of this document or the policy, in whole or in part.

C. Results of Surveys and Interviews

Below is a summary of issues raised in both the mail survey and telephone interviews of APHIS Animal Care employees.

1. Minimum Criteria Need Clarification

The standards in 9 CFR §3.81 emphasize the presence of a physical document called an "environment enhancement plan for primates" at each facility, but the standards contain few solid criteria on which an inspector can judge the content of the plan as "in compliance" or "out of compliance". The regulations state that the plan must address social grouping, enrichment of the physical environment, special considerations, and restraint devices, but what is required in order to address these in a minimally compliant manner is unclear. Some inspectors said they had the impression that the only legally necessary condition for compliance was the existence of the document itself, regardless of its contents. A few commented that once the facility's attending veterinarian approved a plan, it was problematic to enforce additional requirements, even if that plan was very poor.

A few inspectors expressed the concern that without adequately specified criteria and only a notion of an abstract endpoint to achieve (psychological well-being, which can not be directly or unequivocally measured), facilities are free to try, or NOT try, anything--including a very

behaviorally restrictive, barren environment. No one, including inspectors, would have any basis for criticism, until there is proof of "poor performance". Unfortunately, there is no agreement on what "poor performance" looks like. There might be virtually no performance parameter or outcome that could be proven to have been caused by an inadequate environment.

2. Lack of Enforceability

APHIS Animal Care employees recognize that there is a legal question concerning the enforceability of performance standards. Some inspectors said they could recognize a plan that was not in accordance with professional literature or was not "adequate to promote psychological well-being". However, they had concerns about Agency support for particular interpretations or judgement because of the vague language and nature of the performance standard.

3. Minimalistic and One-Sided Enhancement Programs

A common refrain among inspectors was that too many enhancement programs consisted of only one or two types of enrichment, such as feeding of treats or provision with a simple rubber toy, in an otherwise barren, stimulus-poor environment. There is agreement that acceptable enhancement programs should stimulate a variety of normal activities and meet all major areas of behavioral need in a species-typical manner, rather than concentrate on a few limited aspects of behavior (Olfert *et. al.* 1993, Poole 1991b). Many employees supported the idea that enhancement programs be required to address several different aspects of a primate's environment and behavior, beyond the superficial breakdown given in 9 CFR §3.81 ("social", "physical", and "special"). The team received many helpful suggestions on this issue.

4. Questionable Implementation of the Facility Plans

Another problem has been the difficulty in proving actual implementation of an enhancement plan. Animal Care inspectors recommended facilities be required to provide better documentation of implementation.

5. Low Levels of Appropriate Social Grouping

Some Animal Care inspectors felt that there were too many singly housed primates. This is especially true at research facilities and among small licensed exhibitors. Inspectors who inspected public exhibits with singly housed chimpanzees said that the reasons most frequently given for housing these animals singly were that the exhibitor: preferred to have only one chimpanzee at a time; considered them more tractable when single-caged; was ill-equipped to permit socialization of one single-caged chimpanzee with another; and/or was unwilling to transfer or loan a single chimp to other facility, even one equipped to provide a socially enriched environment. All of these reasons reflect convenience for the owner(s), not primary consideration for the psychological needs of the animals.

6. Practices that Perpetuate Socially Incompetent Individuals or Abnormal Behavior

Animal Care inspectors were concerned that dealers involved in the pet trade continue to remove infants from their care-giving parent(s) at an inappropriately early age, for reasons other than medical necessity. These practices are known to produce socially incompetent adults and contribute to the low levels of social grouping already identified.

7. Poorly Furnished Environments

Inspectors reported facilities with cages that did not have a single elevated perch, shelf, or similar structure. Inspectors said they often did not cite the above situations as noncompliant in inspection reports, although they believed the situations were not in accordance with the intent of

the Animal Welfare Act, because they believed the Agency could not or would not support them.

Inspectors mentioned other problems with enhancement plans. Some plans are static, not updated to reflect whether they are working effectively. Some are not updated to be consistent with changes in the facility's population and use of animals. Some plans do not consider variation in individual animals' personalities and rearing histories. Others fail to avoid latent effects of harmful housing or rearing conditions. Inspectors said some facilities solve the problem of abnormal or psychological distress-related behavior by simply selling or transferring the primates to other parties. Facilities that sell or transfer primates after relatively short periods of use have little motivation to concern themselves with cumulative or latent effects on the behavior of their primates because these behaviors will be manifested at another facility.

The urgency of these problems or issues raised by their colleagues motivated the members of the Primate Environment Enhancement Team to move forward with the design of a conceptual model and policy. Another factor they had to consider was how to promote psychological well-being for nonhuman primates in the context of the larger political environment. A strategy had to be developed to fulfill the original intent and language of the Animal Welfare Act, while considering the response of the community affected by any new policy, the approach of other nations and societies also facing similar problems, and the difficulties inherent in scientifically measuring psychological well-being. These topics are discussed in Chapter II.

II. PROMOTING PSYCHOLOGICAL WELL-BEING

A. Intent and Language of the Animal Welfare Act

The Animal Welfare Act states that "The Secretary [of Agriculture] shall promulgate standards... The standards.. shall include minimum requirements .. for a physical environment adequate to promote the psychological well-being of primates" [AWA Sec. 13 (a)(1), emphasis added.]

The Animal Welfare Act was intended to promote the psychological well-being of nonhuman primates, not just prevent abnormal behaviors from occurring. Because there were no standards for primate psychological well-being prior to 1991, no measurable comparisons can be made as to whether the use of performance-based standards has improved the welfare of the animals as intended. As previously stated, most inspectors feel the lives of primates have been improved some, but that overall not enough is being done to provide a "physical environment adequate to promote the psychological well-being of primates", especially in the area of social grouping.

The concept of psychological well-being does not lend itself to precise definition. Facilities are allowed latitude in how they meet the requirements, as long as they achieve the desired results or outcomes. Therein lies the problem, as no one has defined the results desired in terms of something that can be easily observed and recognized.

Some facilities claim their environment enhancement programs are adequate because there are no distressing behaviors or appearances of ill health with their primates. This is a short-sighted view since waiting to improve a minimally enriched environment until a primate starts showing signs of psychological distress was not the intent of the Animal Welfare Act.

The Primate Environment Enhancement Team believes the intent of the Animal Welfare Act was to provide nonhuman primates with the opportunity to express a wide range of non-injurious, species-appropriate behaviors. The team's goal with this policy is to re-emphasize attention to adequate environmental conditions before abnormal behaviors develop.

B. Community Response

Both the regulated community and the interested public have responded to the increasing awareness of the importance of the psychological well-being of nonhuman primates. There is now a wealth of scientific and anecdotal information on the topic. The exhibition and research communities have sponsored scientific research and professional meetings to further knowledge of the subject. The National Research Council (NRC) Institute for Laboratory Animal Research (ILAR) recommended ways in which to assess and promote psychological well-being. The NRC independently arrived at many of the same points that APHIS has arrived at and its 1998 report is an excellent resource for most purposes. "The purpose of this volume is to help scientists, veterinarians, curators, inspectors, duly appointed committees, and others concerned with the psychological well-being of nonhuman primates to deal more effectively with this complex issue" (NRC/ILAR 1998:4).

At the same time, there has been concern over the implementation of the provisions, and members of the public and an animal welfare organization brought a legal suit against USDA [Animal Legal Defense Fund, Inc. *et. al.* v. Daniel R. Glickman (Docket Nos. 97-5009, 97-5031, and 97-5074).]

C. Other Nations and Societies

There is a movement in other nations and professional societies abroad to develop similar provisions for meeting primates' psychological needs. Some have specific recommendations or requirements for achieving them. Jones (1996) has reviewed and compared recommendations of three major bodies influencing European laws on primates produced, held or used for research: the IPS (International Primatological Society 1993); the PVEN (Primate Vaccine Evaluation Network) (Poole and Thomas 1995); and the Berlin Workshop, an international workshop on the Accommodation of Laboratory Animals in Accordance with Animal Welfare Requirements held in Berlin, Germany in 1993 (Poole *et. al.* 1994). Common to all are the following:

1. Physical, physiological, and behavioral needs must be satisfied.
2. The environment must contain sufficient useable space, complexity, and enrichment.
3. Social housing should be the general rule and individual housing should be the exception.
4. The environment should promote a species-appropriate repertoire of behavior.
5. Primates should not be weaned from their mothers at an age that will produce psychological abnormality, prior to 6 months of age.

In addition, the PVEN emphasizes providing climbing structures and vertical space, novelty in the animal's environment, and giving the animal opportunity to exercise control over some aspects of its environment. The Berlin Workshop (Poole *et. al.* 1994) specifies provision of sleeping boxes, climbing structures, and gnawing wood for Callitrichidae (marmosets and tamarins); environmental novelty and variety; and the use of animal training to decrease the stress of handling. It also gives minimum space requirements. Although these requirements are divided into slightly different weight classes than USDA's requirements are, the minimum dimensions required by the Berlin Workshop are generally 1.5 to 3 times larger than USDA's minimums. The Berlin Workshop also states primates kept for long periods should be housed in even larger spaces, but it does not define what constitutes a "long" period.

The United Kingdom Code of Practice (Home Office 1989) contains language that is more specific. The cage volume should enable the animal to exhibit vertical flight reactions, jump, climb, and sit on perches with neither its head nor its tail touching the cage. For Callitrichidae, it specifies "wooden perches, a swing, a wooden nest box, a shelf for feeding, and sufficient shavings to allow foraging." The animals should also be allowed to "jump horizontally from one perch to another." The same cage structures are specified for arboreal, polygamous primates, such as squirrel monkeys. Group-housed macaques and baboons must be given escape routes, sleeping areas with several entrances, and multiple food and water stations.

The Canadian Council on Animal Care (CCAC) provides minimum cage space requirements for primates in research that, for most species, are the same or slightly larger than U.S. minimums. Single housing is "strenuously discouraged" (Olfert *et. al.* 1993). A number of other recommendations are made with respect to social grouping, cage enrichment, exercise and foraging activities (Olfert *et. al.* 1993).

The Australian National Health and Medical Research Council's (NHMRC) official policy requires the following: appropriate social grouping, unless individual caging is justified by an animal ethics committee; grooming opportunities for individually housed primates; access to outdoor enclosures for animals held longer than six weeks; training of isolated animals to facilitate handling; adequate enclosure size to accommodate group housing and varied activities; and foraging opportunities (National Health and Medical Research Council Animal Welfare Committee 1997).

The laws and regulations of some nations concern themselves with the specifics of primate environment enhancement just as the U.S. policy being developed here does. However, they differ from it in other ways. One of these is the animals to which the requirements apply. In the

U.S., the enhancement regulation applies to all primates in facilities regulated by USDA. The requirements apply to primates in zoos and circuses as well as to primates in research[3], breeding, and many other types of facilities. In Europe, the housing of primates in zoos is governed by standards developed under the UK Zoo Licensing Act of 1981 and/or the 1994 standards of the European Association of Zoos and Aquaria (EAZA). These regulatory documents for zoos are far more general than the other European regulatory documents reviewed above, which apply to animals in research laboratories. The EAZA standards state that the welfare of zoo animals is a matter of both "physical and social well-being" (EAZA 1994). Both the UK Zoo Licensing Act standards and the EAZA standards require the provision of enclosure space and environmental structures and substrates appropriate to the needs of the species.

Developing regulatory language with specific details about environment enhancement does not appear to have caused serious problems for the nations above who have tried it (Boisvert 1997, Poole 1997a, and Popovic 1997). In the present era of increasing concordance in regulatory matters to facilitate international trade and commerce, it will be advantageous for the U.S. to adopt criteria and language that will meet with acceptance by other nations.

D. Difficulties Inherent in Measuring Psychological Well-being

The ultimate objective of 9 CFR §3.81 is "psychological well-being" (PWB), a subjective state experienced internally by each animal. It is difficult to define this term and currently there are no ways to measure it directly. Working definitions presume characteristics that are manifested in various indicators (Broom and Johnson 1993, Duncan *et. al.* 1993, Mason and Mendl 1993, Novak and Petto 1991b, Poole 1992).

The indicators that have been proposed include: (1) physical values such as longevity, growth rate, reproductive success, hair coat, and body condition, etc; (2) physiologic values such as heart rate, blood pressure, body temperature, levels of serum cortisol and other hormones, and rates of lymphocyte proliferation or suppression; (3) behavior; or (4) a synthesis of many such measures, perhaps weighted by evolutionary or other contexts (Boinski *et. al.* 1999, Broom and Johnson 1993, Line 1987, Snowdon and Savage 1989).

The assessment of the PWB of each primate relies to some degree on subjective interpretation of these indices, some of which may suggest opposite conclusions (Mason and Mendl 1993, Sackett 1991). For example, Coe found that a change in the social environment of older rhesus monkeys produced positive behavioral changes, but also evidence of reduced immune competence (C. L. Coe 1991). An ideal approach would combine many different measures and take into account differences between individual animals. This is often not feasible and the measurement of many of the parameters would be unnecessarily invasive.

An animal's behavior is still the index most commonly accepted for assessing PWB. It is also the index most readily and consistently available (Olfert *et. al.* 1993, Poole 1991b). To assess PWB, one may look at the animal's general activity level, the percentage of time it spends doing various things, its use of cognitive skills, its maternal behavior, locomotor behavior, play, communication, appetitive and self-maintenance behaviors, its avoidance of predators, its response to novelty and routine husbandry, affiliative behavior, and vocalizations. Environmental effects on vocalizations may provide a rich opportunity for psychological assessment that is only beginning to be applied to animal welfare (Crowell Comuzzie 1993, Mulligan *et. al.* 1994).

How can the welfare implications of an animal's behavior be interpreted and what does it tell about the adequacy of its environment? The performance of abnormal behaviors, such as stereotypies, is interpreted to reflect a lower level of well-being and an inadequate environment (Bayne *et. al.* 1992a, Broom and Johnson 1993, Maple 1979, Olfert *et. al.* 1993). Some may assert that the absence of such behavior indicates well-being and therefore an adequate

environment. But stereotypies do not always indicate current suffering or currently inadequate environments. Current abnormal behavior may reflect past, not present, environments (Brent and Hughes 1997, Broom and Johnson 1993, G. J. Mason 1991a and 1991b, Mason and Mendl 1993). Two conditions known to result in aberrant behavior that may persist into adulthood or be expressed long after infancy are: (1) restricted social environments during development; and (2) early infant separation from the mother. Some aberrant behaviors resulting from these conditions are resistant to treatment (Capitanio 1986, Mason and Berkson 1975, Novak and Drewson 1989:166, O'Neill 1989). Some are eventually reversible after considerable ameliorative efforts (Fritz 1989, Kessel and Brent 1997).

This underscores the importance of directing major regulatory efforts toward requiring environments and practices less likely to be associated with the expression of aberrant behaviors, either immediately or later in life. Put in a constructive way, facilities should be required to enhance the environment of nonhuman primates in a way that promotes the expression of a wide variety of positive, normal behaviors. Prevention is better than treatment, in mental health as in physical health (Schapiro *et. al.* 1996a). The USDA's obligations under the Animal Welfare Act include requiring standards aimed at prevention of problems.

The performance of stereotypies remains an important and valid indicator of welfare problems for most situations (Broom and Johnson 1993, Olfert *et. al.* 1993, Toates 1995, Wemelsfelder 1993). The benefit of any interpretive doubt should go to the animals (Bekoff 1994, Duncan *et. al.* 1993). Many authors have concluded that welfare should also be seen as more than just absence of negative behavior (Bayne 1989:27, Broom and Johnson 1993, Poole 1992, Segal 1989 Preface). The expression of species-typical or species-appropriate behavior should be the goal of an enhancement program.

There has been some debate about whether normal behavior reflects adequate well-being or whether the performance of specific behaviors themselves is necessary to cause well-being (Petherick and Rushen 1997, Veasey *et. al.* 1996). In either case, it is important that USDA regulations require facilities to provide captive primates with an environment where they can express a wide range of normal behaviors.

E. Species-Typical Behavior (STB)

USDA regulations state, "The physical environment in the primary enclosures must be enriched by providing means of expressing non-injurious species-typical activities" [U. S. Department of Agriculture, Animal and Plant Health Inspection Service 1998: 9 CFR 3.81(b)].

What constitutes STB or a normal behavioral repertoire in captivity? A primate in captivity will not be able to exhibit the full range of behaviors that occur in nature. Colony managers would not want to promote infanticide or harmful aggression. The primate itself would not wish to suffer infanticide, predation, or other conditions that sometimes occur in nature. In passing the Animal Welfare Act, Congress did not intend such extremes to be promoted in the maintenance of captive primates. Therefore, in this policy, the term "species-appropriate behavior" has been adopted instead of the more common term, "species-typical behavior."

The pitfalls of attempting to stimulate every natural behavior have been discussed by Veasey *et. al.* (1996). (See also Rosenblum and Andrews 1995.) Putting aside the extremes, behavior observed in nature serves as one of the most useful guides to what a captive environment should allow (McGrew 1981). Observations of captive but free-ranging primates may provide the best of both worlds (Newberry 1995, O'Neill *et. al.* 1990). Environmental preference testing can also be used to clarify the picture (Bayne *et. al.* 1992a, Line 1987). As Kaumanns (1997) stated, captive conditions "should still fit within [the] adaptive potential" of the animal. Differences between

individuals of a species, as well as between species, must also be taken into account (Clarke and Boinski 1995, Laudenslager and Boccia 1996, Suomi and Novak 1991).

In summary, although difficulties are inherent in applying USDA's regulation concerning environment enhancement to promote the psychological well-being of nonhuman primates, we have learned a great deal since the amendments to the Animal Welfare Act were passed in 1985 and 9 CFR §3.81 was adopted in 1991. USDA now has a basis for creating more specific guidance on environment enhancement and for bringing the U.S. program into step with international developments. The central idea is that nonhuman primates must be given an environment in which they can express the wide range of behaviors practiced by others of their species in nature. Their captive environments must be enhanced to give them opportunities to exhibit these behaviors. When such conditions are achieved, the intent of the Animal Welfare Act to promote their psychological well-being will be fulfilled.

III. CRITICAL ELEMENT CONCEPT

There is a consensus emerging in the literature on primate enrichment that "species-typical" or "species-appropriate" behavior should be the goal of enhancement programs, and that it is important for the animal to be able to express a "normal repertoire" or a "full range" of normal behavior--a range that is complete and balanced (Brent and Long 1995, Brent and Stone 1996, Chamove and Anderson 1989, Fragaszy 1991, Olfert *et. al.* 1993, Poole 1991b and 1992, Rose 1994, Toates 1995, Line 1987). Scientists believe that it is not enough for individual or groups of primates to express just a few "normal" behaviors. Environments should be complex enough to allow a variety of activity and stimulus-response options. Also, it is difficult to interpret an animal's behavior and activity levels if it has relatively few realistic choices of behavior in that environment.

Captive animals are limited in their ability and/or motivation to move about freely and carry out many of the behaviors their species normally exhibit in a natural environment. As stated in Chapter 1, USDA inspectors have found that many current enhancement programs are narrow and address only one or two aspects of the animal's life. In order to correct this problem, USDA must stimulate the addition of diverse environmental elements that can promote a wider repertoire of species-appropriate behavior. This need has motivated the Primate Environment Enhancement Team to develop the concept of critical elements.

There are distinct categories of activity or behavior, each of which should be present to some extent to round out a normal behavioral repertoire. Similarly there are categories of enhancement strategies or elements of an environment that address these behavioral needs and/or promote the expression of these behaviors. Such categorizations are useful for providing structure to an enhancement program and to regulations and policies. Numerous sources in the primate enrichment literature show similar categorizations of these elements (Bloomsmith *et. al.* 1991, Bowden 1988, Keeling *et. al.* 1991, Line 1987, Maple 1979a, Newberry 1995, Olfert *et. al.* 1993, Poole 1992 and 1998, Rosenblum and Andrews 1995, Schapiro and Bloomsmith 1995). They share the idea that it is critical to touch upon each element appropriately, rather than concentrate on one or two aspects of the normal behavioral repertoire.

The National Research Council in its report on *The Psychological Well-Being of Nonhuman Primates* discusses four main determinants of psychological well-being:

Beyond reasonable physical well-being, psychological well-being is enhanced by

- Appropriate social companionship.
- Opportunities to engage in behavior related to foraging, exploration, and other activities appropriate to the species, age, sex, and condition of the animal.
- Housing that provides for suitable postural and locomotor expression.
- Interactions with personnel that are generally positive and not a source of unnecessary stress. (NRC/ILAR Report 1998:2)

The report emphasizes the importance of flexibility since no single approach will be effective for all animals. Measuring and validating the effectiveness of an environment enhancement program is also vital to ensure that psychological well-being is actually improved.

Nevertheless, a comprehensive program to improve the psychological well-being of nonhuman primates **will attend to each of the variables and include a means to test and assess the influence of each** [NRC/ILAR Report 1998:2, emphasis added].

Other documents outline similar methods with several elements or variables (International Primatological Society 1993, Olfert *et. al.* 1993, Poole *et. al.* 1994, Poole and Thomas 1995).

These differ vastly from minimalist programs in which facilities adopt a single element such as feeding food treats as the mainstay of their enhancement, while keeping the enclosures barren and neglecting other environmental features. Minimalistic programs such as these do not stimulate a wide range of species appropriate behaviors and probably increase the potential for obesity. A recent study by Boinski *et. al.* (1999) exemplifies the importance of variety and a minimum level of enrichment. Providing both a foraging device and two toys to single housed *Cebus apella* markedly increased species-appropriate behavior and decreased abnormal behavior. These behavioral changes were correlated with expected effects on plasma cortisol. The overall positive effect was dramatically greater with both of these enrichments than it was with either enrichment alone, and the baseline environment already included cage furniture and daily multiple feedings of standard diet and treats.

One-sided programs have persisted at some regulated facilities because the current USDA regulations appear to allow them. Stimulation of only one type of normal behavior should not be considered adequate for compliance. Such programs can be compared to a diet that contains an excess of some nutrients and inadequate levels of others. A nutritionally balanced diet will provide certain vitamins and minerals plus a number of calories distributed among different forms of metabolizable energy. A food pyramid can be constructed to represent the relative importance of the essential food groups. A variety of individual foods are available within each food group to provide the necessary nutrients in appropriate proportions. Many food items are equivalent in value, but some are more palatable or costly than others.

This food pyramid model is analogous to the critical element concept in the Primate Environment Enhancement policy being developed for USDA here. The policy states that five elements are critical to environments that adequately promote the psychological well-being of nonhuman primates:

1. Social grouping
2. Social needs of infants
3. Structure and substrate
4. Foraging opportunities, and
5. Manipulanda.

A minimally acceptable program of environment enhancement will contain all five. A given enhancement strategy or environmental feature may simultaneously address more than one element. The extent to which each enhancement strategy may be deemed to satisfy more than one element simultaneously is a matter of professional judgement and should be evaluated on a case-by-case basis. In addition to the five critical elements, any enhancement plan should give consideration to two other aspects of the environment: stimulating all five senses; and providing the animal novelty and control over aspects of the environment.

Regulated facilities must target each critical element in their primates' environments, address it in their plan, and implement the plan in a balanced way. To meet the desired objective for each critical element, a variety of options exist. The options chosen should be appropriate for the species and individual characteristics of the animal as well as its intended use by the facility. The facility must observe the effects on the animals' health and behavior and continue to make modifications as necessary.

The essence of the performance-based standard approach is that regulated facilities assume responsibility for the end results and are given flexibility in how they approach achieving them.

For this to be successful, facilities must clearly understand the goals and try different methods until they get the desired results.

We believe the majority of regulated facilities intend to voluntarily comply with the law to the extent they are able. However, educational efforts alone are not sufficient to gain compliance. There always exist some facilities that must be compelled by enforcement. USDA cannot overlook the failures of members of the second group or it will hurt the members of the first group. Fairness in government requires that if regulations exist, they are enforced uniformly and consistently. Those who voluntarily comply with the intent of the law should not be penalized for it by suffering a disadvantage relative to others who circumvent regulations.

In order for minimum standards to be enforceable, the standards must have definition and structure. It must be clear to all facilities when violations occur and enforcement action is necessary. The concept of minimum criteria has been useful in government regulations because it objectifies what is unacceptable and increases fairness. Some regulatory areas such as primate psychological well-being are so complex that specifying criteria in detail would require volumes of legal language and years to develop. There will always be the need for the careful judgement of a qualified professional who is trained in Agency policy based on regulatory experience, ethics, and applied ethology. USDA's policy has been developed to capture these principles and while allowing facilities as much flexibility as necessary.

IV. LITERATURE REVIEW AND DISCUSSION

In order to develop the new policy on environment enhancement to promote psychological well-being of nonhuman primates, USDA's Primate Environment Enhancement Team conducted a review of professional literature related to the ecology, natural history, and behavior of primates. The findings of this literature review are presented and discussed in the order the five critical elements are listed in Chapter III: social grouping; social needs of infants; structure and substrate; foraging opportunities; and manipulanda. After the five critical elements are discussed, findings are presented for two additional considerations that should be built into each environment enhancement plan--sensory stimulation, and novelty and control. This chapter is intended to explain the reasons for the policy, but it may also be useful to those who own primates and wish to understand their needs generally before beginning a detailed quest for information on the species in their care.

The team reviewed publications of scientists who have observed primate behavior in nature and under zoo and laboratory conditions. It also looked for advice and strategies directed to those who manage colonies of primates. It sought to understand what scientists and practitioners today know about each critical element and what the requirements to each one should be. The field of knowledge has grown tremendously since the Animal Welfare Act's 1985 amendments were passed. The number of articles published is increasing every year, as are the number of electronic mail discussions and sites on the World Wide Web devoted to the topic. Although the team was not able to survey all the literature, it was able to review enough sources to draw conclusions about what environmental conditions promote the psychological well-being of nonhuman primates. Sources are listed at the end of this paper. The interested reader who is unable to locate information sought may try the Animal Welfare Information Center of the National Agricultural Library, 10301 Baltimore Boulevard, Beltsville, Maryland 20705, (301) 504-6212. The Center's Email address is: AWIC@NAL.USDA.GOV. For document delivery, another resource is the Wisconsin Regional Primate Research Center Library at the University of Wisconsin in Madison, Wisconsin 53715-1299, (608)263-3512. The Email address is: jacobsen@primate.wisc.edu. The webpage address is: http://www.primate.wisc.edu/pin/primpro.html. The Primate Information Center at Box 35730, University of Washington, Seattle, WA 98195-7330, (206) 543-4376, is an indexing service for scientific literature on all aspects of nonhuman primate research. Its manager, Jackie Pritchard, is at: plj@u.washington.edu. The webpage address is: http://www.rprc.washington.edu/pic1.htm.

A. Social Grouping

1. The Social Nature of Primates

USDA regulations state that, "The environment enhancement plan must include specific provisions to address the social needs of nonhuman primates of species known to exist in social groups in nature." [U. S. Department of Agriculture, Animal and Plant Health Inspection Service 1998:9 CFR §3.81(a)].

Social interactions are considered to be one of the most important factors influencing the psychological well-being of most nonhuman primates. (NRC/ILAR Report 1998:13)

Nearly all primates have some tendency to seek the company of their own kind at times other than mating (McGrew 1981, Rowe 1996, Pereira *et. al.* 1989b, Fleagle 1998). Even within those few species known as "solitary"--orangutans and most nocturnal prosimians--individuals of certain age or sex classes can still be found in social associations at certain times (Bearder 1987, Rodman and Mitani 1987, Rowe 1996, Van Schaik and Van Hoof 1996). Despite their solitariness in the wild, adult orangutans have been kept in compatible social groups in captivity (Maple 1979a, Perkins 1992), such as at the Singapore Zoo (Poole 1987), where allogrooming and social

play among adult females was much higher than one would predict from behavior observed in the wild (but see also Markham 1990). The remarkable sociality of the primate order in general is the most relevant characteristic for their humane housing. This social tendency may be redirected toward animals of other species, including humans (Collazo 1989, Hediger 1964, Mason and Kenney 1974).

a. Social organization

The gregariousness of a primate in nature varies not only with its species, but may also vary with its age, sex, kinship to others, the season, the habitat, and the particular activity. The composition of a group that sleeps together is not necessarily the same as that of the foraging or breeding group (Cheney *et. al.* 1987, Jolly 1995, Rowe 1996). Group sizes can range from two, as in a monogamous pair of gibbons with no offspring, to 400, as in some hamadryas baboon troops (Rowe 1996). Bolivian squirrel monkeys live in large, but sexually segregated groups, enforced by the females, except during the breeding season (Williams and Abee 1988). Foraging associations between some primate species also occur and may provide a basis for mixed-species housing (Bernstein 1991, Bramblett 1989a, Thomas and Maruska 1996).

Jolly (1985) summarizes the breeding systems of many species. Monogamy, polygamy, polyandry, and multi-male, multi-female groups are all represented among the many primate species and those social structures are species specific. Some species can exhibit more than one breeding system, for example, many Callitrichidae can be either monogamous or polyandrous. Generally one male or multi-male groups are the rule among Old World Anthropoids; monogamy and polyandry, as well as multi-male, multi-female groups, are common in New World Anthropoids.

Close social bonds may exist between heterosexual breeding partners and/or between adult males, adult females, among juveniles, between parents and offspring, between infants and other kin, between non-kin. These patterns of bonding and association are also species specific and are often determined by degree of kinship (DeWaal 1993, Gouzoules and Gouzoules 1987). For many species, kinship appears to be the ultimate cause of social bonds between non-mated individuals in nature. But in captivity, if certain conditions are met and group formations are made with care, affiliative bonds can readily form between unrelated individuals that would not otherwise associate peacefully in nature (Gust *et. al.* 1996, Meshik 1994, Vermeer 1997, Williams and Abee 1988).

The generalized fear of strangeness or xenophobia that appears to characterize many primates accounts for the difficulties associated with socializing unfamiliar individuals together in captive settings (Bernstein 1991). Even relationships between primates in an established pair or group are not without stress and hostility, in the wild or in captivity. Primate societies are rarely composed of members of equal social rank, but rather consist of dominant and subordinate members. Some species tend to show strict and stable dominance hierarchies while others have more unstable or non-linear arrangements (Jolly 1995, Fragaszy 1994). Changes in group structure or dominance status are associated with physiologic evidence of stress, which may persist long after the event (C. L. Coe 1991, Ray and Sapolsky 1992, Van Schaik *et. al.* 1991).

In species such as guenons that normally live in groups consisting of one adult breeding male with several related females and immature offspring, two adult males are not likely to be compatible companions for each other in captivity (Cords 1987). But this does not mean that either male is unsuitable for social housing. It may simply be a matter of finding the right kind of social partner(s). Guenons are reportedly tolerant of social partners of other species (Bramblett 1989).

Patterns of emigration from the natal group and immigration or transfer into other groups is also species specific. Knowledge of these patterns is essential for successfully forming pairs or groups in captivity, managing group sizes, and assuring the proper developmental environment for captive juveniles (Williams and Bernstein 1995). When it is necessary to remove individuals, it should be done in a way that minimizes disruption of stable social structures, and removals should approximate natural patterns of change to the extent practical (McGrew 1981).

In some species such as gelada baboons or gorillas, young males leaving their natal groups may travel alone for a while or may join together in bachelor groups. For a given individual in the wild, this arrangement is usually temporary, since the objective is to join a reproductive group (Jolly 1995). In captivity, squirrel monkeys, guerezas, lion-tailed macaques, and gorillas have been managed as bachelor groups (Harcourt 1988, Vermeer 1997, Watts and Meder 1996). In chimpanzees, young females normally emigrate from their natal groups and males form the cohesive core of societies (Goodall 1986). Chimpanzee males may also be kept in bachelor groups (Alford 1995).

b. Social signals

One of the most important primate behaviors associated with social living is the wealth of signals that communicate emotional states or other information between individuals. The signals may be visual, vocal, olfactory, or tactile. They can convey dominance, submission, intent to attack, anxiety, reconciliation, reassurance, alliance, sexual receptivity, a solicitation for grooming or play, a willingness to nurse, territorial boundaries, and so on (Estes 1991, DeWaal 1989, Rowe 1996, Zimmerman *et al.* 1980). Knowledge of these communicative and associated sensory abilities have led to various sensory enrichment ideas (Buchanan-Smith 1997, Shepherdson *et. al.* n.d.).

Visual signals include facial expressions, gestures, postures, and athletic displays of jumping, running, and object manipulation (Cheney *et. al.* 1989, Estes 1991, Goodall 1986, Zimmerman 1980). Vocal expressions can be context and gender specific (A. P. Clark and Wrangham 1994, Palombit 1992, Scott 1997). Prosimians and most New World Monkeys use odors to mark territory, indicate status, or compete with rivals (Jolly 1995, Ruiz 1993, Zimmerman *et. al.* 1980).

c. The importance of grooming

Grooming is the most important form of tactile communication and stimulation for primates (Olfert *et. al.* 1993). Social grooming can account for 10-13% of the daily activity budgets of rhesus macaques (Malik 1986). Chopra *et. al.* (1992) found that grooming was the most frequent social interaction in rhesus monkey troops in various habitats, generally beginning immediately after the first feeding period in the morning and continuing throughout the day. In capuchins *(Cebus spp.)* grooming is the primary activity during daytime rest (Robinson and Janson 1987). One grooming bout observed between a wild chimpanzee and her adult son lasted 2 hours and 45 minutes (Goodall 1986).

Grooming is the most critical activity in maintaining social bonds for most species (Prince *et. al.* 1989, Williams and Bernstein 1995). Jolly (1985) has called grooming "the social cement of primates from lemur to chimpanzee." Relaxed and affectionate grooming bouts between two primates are frequently seen by human care givers as an indication of successful affiliative bonding (Crockett *et. al.* 1997, Reinhardt *et. al.* 1995b). Grooming is not the only tactile interaction important for social cohesion and harmony: embracing, huddling, patting, kissing, and the tail-twining seen in titi monkey pairs are others (Cheney *et. al.* 1987, Jolly 1985).

2. Social Communication in Captivity

Communication between animals can be used by managers to recognize affiliative or stable bonds as well as aversion or impending aggression (Bernstein 1991, Rosenblum and Andrews 1995). Dominance relations can be established between laboratory macaques through visual signals between two individuals in adjacent cages and are an important tool for predicting successful pair introductions (Lynch 1998, Reinhardt 1995b).

It is therefore important that captive environments for primates allow for the adequate expression of social signals by the sender and reception by the receiver. Where postures and positions are part of the behavioral repertoire by which individuals normally establish or maintain social relationships, cages must supply enough room to safely express them. Other characteristics of the physical environment, such as furnishing and cage placement, must accommodate signaling. Threat signals can be a source of distress for recipients. In one case, a singly-caged male rhesus macaque persistently expressed abnormal behavior and severe anxiety when housed where he was in direct view of a dominant male. The situation was improved somewhat by moving the subordinate male's cage out of view of the other animal (Baer 1998a).

The expression of olfactory and tactile cues requires appropriate substrates for scent-marking and opportunities for contact, proximity, and avoidance. Cage boundaries do not stop olfactory signals. In common marmoset (*Callithrix jacchus)* colonies, olfactory and visual cues given by dominant females can suppress ovulation in subordinate females housed in separate cages in the same room (Tardif *et. al.* 1994). Because of the importance of scent-marking to New World species, it is highly recommended that sanitization of various surfaces and furniture within the cage be done sequentially, rather than all at once, so that a familiar territorial scent is always present (Buchanan-Smith 1997, NRC/ILAR 1998).

Whether a primate correctly uses and interprets social signals depends on its social experience and rearing history. A primate learns the customs of its own kind from adults or older peers during periods of early development (Fairbanks 1993, Fritz 1986, Jolly 1985). Young rhesus macaques with restricted social rearing may launch into "suicidal" attacks on mature adult males, apparently because the abnormally-reared animals are unable to recognize the danger (Mitchell *et. al.* 1966). A rhesus harem headed by a male reared in isolation had more problems with aggression and wounding than harems led by males reared by their mothers or peers (L. Watson *et. al.* 1995). Bernstein (1991) suggests that lack of shared communication mechanisms might explain instances where groupings of animals of different species began without overt hostility but later deteriorated into violence.

3. Research Findings on Social Housing and PWB

Primates are clearly social beings and social housing is the most appropriate way to promote normal social behavior and meet social needs. However, there is no doubt that there are risks and negative impacts associated with both individual and social caging in captivity.

The relative benefits and costs to the animal of either alternative have been discussed extensively in primatological literature and are reviewed here. There is an emphasis on species used in laboratories, where single caging continues to be more common than in other types of facilities.

a. Detrimental effects of single-caging

Many authors have described the pronounced association between abnormal behaviors and/or physiological disturbance and single cage housing (Bayne *et. al.* 1991, Brent and Hughes 1997, Goosen 1988, Goosen *et. al.* 1986, Schapiro *et. al.* 1996a, Visalberghi and Anderson 1993, Watts and Meder 1996, Woolley 1997). In one study, chimpanzees that were moved from group housing to single caging exhibited increased stereotypical behaviors in the short term (Brent *et.*

al. 1989). Individual caging of infants and juveniles impairs animals' social skills, makes them more difficult to socialize later in life, and may result in abnormal reaction to stimuli (Capitanio 1986, Fritz 1986, Louwerse *et. al.* 1997, Mason, W. A. 1991, Prince *et. al.* 1989, Young *et. al.* 1996). Walsch *et. al* . (1982) have stated that "even relatively complex laboratory environments, in the absence of opportunity for interaction with conspecifics, disrupt and seriously damage psychological processes in the chimpanzee".

b. Beneficial effects of social housing

Many beneficial effects of social housing are well documented. Social grouping reduced abnormal behavior in previously individually caged macaques and baboons at a pharmaceutical laboratory (Woolley 1997). Group-housed squirrel monkeys exhibited more normal behavior than individually-housed ones (Spring *et. al.* 1997). Social enrichment for young rhesus macaques both increased species-typical behavior and reduced abnormal behavior (Schapiro *et. al.* 1996a). The well-being of adult female rhesus macaques, based on behavior, was improved after a switch from single to pair housing; measures of physiology and reproduction did not indicate that the pairing caused significant stress (Eaton *et. al.* 1994). In juvenile squirrel monkeys, the presence of a peer mediated stress responses (stress vocalizations and plasma cortisol) to manual capture and exposure to a strange environment (Hennesy 1984). A familiar conspecific plus a familiar environment mediated the stress response to maternal separation (C. L. Coe *et. al.* 1987). Similar results have been obtained for pigtailed macaques and bonnet macaques (Laudenslager and Boccia 1996). In another study, cell-mediated immune function in pair-housed adult rhesus was superior to that of single-caged controls (Schapiro *et. al.* 1997b). Social companions lowered blood pressure in baboons (Coelho *et. al.* 1991), and pig-tailed macaques being groomed by conspecifics had reduced heart rates (Boccia 1989). Where nonhuman primates are subject to frequent manipulation and exposure to unfamiliar environmental stimuli, the presence of a compatible conspecific may be significant in helping them to cope with these realities of captive life (Gust *et. al.* 1994).

c. Avoiding potential detrimental effects of social housing

There have also been concerns over potential detrimental effects of pair or group caging versus individual caging. These effects can include social stress, competition for food, disease transmission, woundings, and the possible need for contraception. Gust *et. al.* (1996) found that cortisol levels were increased in pig-tailed macaques after group formation. Christopher Coe (1991) detected reduced cell-mediated immunity in geriatric rhesus monkeys when paired with juveniles, though such effects were not evident in the geriatrics' behavior. There is certainly also a risk of wounding during social caging, especially in reportedly "aggressive" species like macaques. However, pair housed rhesus at one facility required less veterinary treatment than rhesus in single or group caging (Schapiro and Bushong 1994). The conventional wisdom has been that species with this type of social organization are too difficult to pair or group in laboratories (Rhine and Cox 1989, Williams and Bernstein 1995). One resocialization of formerly single caged rhesus macaques resulted in aggression and increased stereotypies (Ljungberg *et. al.* 1997).

But there are also many instances of compatible pairs or groups of these species (Seelig 1998). Long periods of individual housing do not appear to reduce the need or desire for social contact (Taylor *et. al.* 1998). Animals that have been socially isolated have been successfully resocialized (Fritz 1989, Kessel and Brent 1997, Reinhardt 1994b). At one facility, adult male rhesus were paired with an 80% success rate, even though they had a history of being single-caged (Reinhardt 1994a).

Reinhardt *et. al.* (1995b) analyzed evidence for and against social housing of macaques in research facilities and concluded that the commonly given reasons for avoiding it were not supported by evidence. Even some of the infectious disease research commonly performed with

chimpanzees does not appear to require single caging (Prince *et. al. 1989*). Visalberghi and Anderson (1993:8) have stated: "The gap between principles derivable from constantly updated knowledge on primates' psychological and physiological well-being and many existing regulations and practices is wide and unfortunate."

4. Management of Social Groups in Captivity

In creating appropriate social groupings in captivity, there are many factors to consider: Should animals be paired or in larger groups? What will be the group structure in terms of age and sex? What is the rearing history and personality of the candidates? How will group size be regulated? By what method will the group be formed and members added or removed artificially, if necessary? By what means will compatibility be determined? What equipment and enclosures will be needed and how will space be structured? How will humans fit into their social life, and will a behavioral conditioning program be implemented? How will the purpose and use of the animals, or their medical treatment, affect social stability? What will be done with socially incompetent individuals?

Many criteria for selecting partner candidates and methods of introduction and group formation have met with success and failure, perhaps even in the same setting. Many factors may impinge on the likelihood of success of any pairing or grouping, including individual personality (Reinhardt *et. al.* 1995b). Some grouping methods seem less prone to risk than others, and certain precautions seem well-advised.

Infants and juveniles of most species are easiest to introduce to established groups, to adults, or to each other. For animals like male macaques, an infant or juvenile can make good social partner (Fragaszy *et. al.* 1994, Reinhardt *et. al.* 1987, Schapiro *et. al.* 1994). All introductions should be closely monitored for as long as possible before leaving animals unattended, and there should be a plan for separating animals quickly if there is an attack. Since virtually any social change is a stressor, it is best that initial introductions occur at a time when other environmental factors are stable (Capitanio 1998). Beyond that, advice for pair or group formation among the major social types of primates varies. Different reports have yielded conflicting information on the role of prior familiarization, age differences, presence of the opposite sex, "neutral" cage environments, and other factors (Alford *et. al.* 1995, Bernstein 1991, Brent *et. al.* 1997, Crockett *et. al.* 1994, Reinhardt 1994a, Seelig 1998).

The method of introduction, as well as the rearing history, age, and sex of partners, may influence pairing success in macaques (Schapiro *et. al.* 1994). Crockett *et. al.* (1994) were able to compatibly establish only 6 of 15 attempted pairs of male cynomologous macaques (*Macaca cynomologus*) in a two week period. However, pairs were separated and re-paired daily. Higher rates of success in the same species and sex occurred at a facility where pairs were not continually re-separated (Lynch 1998). At this laboratory, 16 of 17 attempted male cynomologous pairs were established and remained compatible after one to two years. These researchers used a nine step partner evaluation and introduction technique that has been successful elsewhere in establishing long-term compatible pairs of adult male rhesus, adult female rhesus, adult male stump-tailed macaques and adult female stump-tailed macaques (Reinhardt *et. al.* 1995b). In Lynch's laboratory, an additional six pairs of male cynomologous were formed using an exercise cage (Lynch and Baker 1998). Similar techniques have been used to form compatible isosexual pairs of cynomologous macaques (Mack 1998) and to socialize pig-tailed and bonnet macaques (Taylor and Laudenslager 1998). At an animal sanctuary 18 former laboratory cynomologous macaques have been paired (Asvestas 1998).

Seelig (1998) contrasted the methods used in five studies on the pairing of adult male cynomologous macaques. The widely varying success rates in these studies suggest that adult male cynomologous macaques are more challenging to pair than other combinations of species and sexes. Where full-contact housing is not successful for these adult males, a safe alternative

is adjacent caging with privacy panels and vertical bars that permit allo-grooming. In a test of one such design, all male-female and all female-female pairings were successful. Forty of 45 male-male pairs were successful, and nearly half of these successful pairs had not been compatible when previously housed together in one continuous enclosure (Crockett *et. al.* 1997). These cages can be used with partners of the opposite sex without resulting in unwanted pregnancies.

There are other reports of successful pairing or grouping of many species in pharmaceutical, toxicological, and other research settings: cynomologous macaques (Brinkman 1996, Buerge and Weber 1997, Heath 1989); rhesus macaques (*Macaca mulatta)* (Bowditch *et. al.* 1997, Buerge and Weber 1997, Fligiel and Reinhardt 1994, Louwerse *et. al.* 1997); pig tail macaques (*Macaca nemestrina*) (Gust *et. al.* 1996); rhesus macaques (Brown *et. al.* 1997); capuchins (*Cebus*) (Fragaszy *et. al.* 1994); chimpanzees *(Pan troglodytes)* (Alford 1995); squirrel monkeys (*Saimiri)* (Salzen 1989); bonnet macaques (*Macaca radiata)* (Taylor *et. al.* 1998).

Squirrel monkeys seem particularly well-suited to being kept in large groups, in a free-ranging room (King and Norwood 1989). An tame adult brown capuchin (*Capucinus apella*) who had formerly been a pet was successfully introduced to an existing group (Anderson *et. al.* 1991). Juvenile and adult female capuchins can be introduced to existing groups without great difficulty; males can also be integrated into groups that have no resident adult males (Fragaszy *et. al.* 1994).

For other descriptions of introduction techniques, see the following sources: Baer 1994, Byrum and St. Claire 1998, Cooper *et. al.* 1997, Kurth and Bryant 1998, Schapiro *et. al.* 1994, Reinhardt *et. al.* 1995b, Fritz 1994, Watts and Meder 1996, Ljungberg *et. al.* 1997, Morland *et. al.* 1992, Fragaszy 1994, Alford *et. al.* 1995. Behavioral conditioning (training) has been used to improve compatibility (Bloomsmith *et. al.* 1994).

5. Separations

Once animals have been compatibly paired or grouped, separating them is stressful. Any disruption of attachments will be stressful, whether it is separation from the mother, a sibling or nursery peer, a cage partner, or a room-mate in a separate cage (Capitanio 1998, Mendoza and Mason 1986, Prince *et. al.* 1989, Suomi *et. al.* 1975). Separations occur naturally in the wild, as part of normal weaning, death, and emigration. Stressful effects may be reduced in group-living species by the presence of group mates and/or minimizing other environmental changes (Coe *et. al.* 1987b, Gerber *et. al.* 1997, Reinhardt 1995b).

After pairing, the frequency and duration of unnecessary separation of an animal from its companion should be minimized (Olfert *et. al.* 1993). In the past, traditional laboratory settings made this nearly impossible. More recently, refinements in animal handling and restraint methods are making separations for husbandry, treatment, and experimental purposes increasingly unnecessary. Primate pairs have been trained to cooperate in a variety of clinical and husbandry procedures (Brown *et. al.* 1997, Gilbert and Wrenshall 1989, Reinhardt 1997d, Reinhardt *et. al.* 1995b, Turkkan 1989). Where separation is necessary, social partners should be able to maintain as much visual and auditory contact as possible (Lynch 1998, Reinhardt *et. al.* 1995b, Washburn and Rumbaugh 1991). It is also beneficial to prevent total separation by providing opportunities for tactile contact. If this cannot be done, providing items for tactile stimulation is the next best alternative (Lam *et. al.* 1991).

6. Choosing Between Pair and Group Housing

We have established that social housing is superior for most social primates, but should it be pair or group housing? In captivity, primates tend to be held as single animals, in pairs, or small social groups. Maintaining groups of three or more in captivity can be more difficult than maintaining

pairs. Many of the references examining overt aggression in group housing situations involve groups of three or more in confined spaces (Bernstein 1991, Reinhardt 1991, Rhine and Cox 1989). Reinhardt *et. al.* (1995b) discusses why housing animals in pairs may be the best compromise between single and group caging for the majority of laboratory situations, even though the pair is not a species-typical social arrangement for most of the species commonly kept in laboratories.

For monogamous pair-bonding primates such as Aotus, Callicebus, and some Callitrichidae, only two adults will likely be tolerated, and these must usually be of opposite sexes (Baer 1994, NRC 1998).

Larger groups may be necessary for some species such as chimpanzees and squirrel monkeys (K. C. Baker 1996, Maclean *et. al.* 1987, Mendoza and Mason 1989, Olfert *et. al.* 1993, Prince *et. al.* 1989, Young *et. al.* 1996). K. C. Baker (1996) concludes that even one or two conspecifics are not sufficient to meet the extraordinary social needs of chimps in stimulus-restricted environments. Macaques, vervets, and squirrel monkeys have been successfully kept in medium-sized groups. So far, large social groups exist only at a few zoos and laboratory breeding colonies.

7. Social Adjustments and the Physical Environment

Social compatibility can be influenced by environmental structure and complexity (Chance *et. al.* 1983). Appropriate enclosure size, design, and furnishings can make attempts at social housing and the process of introduction more successful. In one group of chimps, aggressive behavior increased as enclosure space decreased (Howell *et. al.* 1993). Two unfamiliar individuals, at first pairing, may actually require more than twice the minimum space required by USDA for each individual alone because of the distance they feel they must maintain from each other. As previously discussed, there must also be room enough for appropriate social signals.

Physical features such as visual barriers, privacy panels, mesh dividers, multiple shifting points, escape routes, refuges, and perches have all been recommended to increase chances of successful pairing or grouping (Adang *et. al.* 1987, Aureli *et. al. 1997*, Bettinger *et. al.* 1994, Bramblett 1989a, Fouts 1989, Fritz 1986, Fritz 1989, Goosen *et. al.* 1984, Mendl and Newberry 1997, Prince *et. al.* 1989, Seier 1996, Watts and Meder 1996). Williams *et. al.* (1988) found that among mixed-sex group-housed squirrel monkeys, housed in cages with perches at multiple levels, males (which are subordinate to females) occupied perches below those preferred by females. Without a choice of perches, males were forced to stay on the floor. Mesh tunnels, connecting passages, coupled cages, and large exercise pens have been used to facilitate social introductions and periodic social contacts (Buchanan-Smith 1997, Field *et. al.* 1992, Lynch and Baker 1998, Marriott *et. al.* 1993). Primates in zoos need appropriate visual barriers or psychological distance from human visitors (Chamove *et. al.* 1988).

Food, water, shelter, and enrichment devices should be distributed to reduce hoarding (Lynch 1998). Foraging enrichments that disperse individuals and occupy their time can reduce tension and distract them from aggression (Boccia 1989). Behavior modification techniques, such as those used for most animal training, reduced social aggression in chimps (Bloomsmith *et. al.* 1994).

Nearly any two conspecifics might be housed together "compatibly" given just the right environment. For some individuals, this could entail huge, complex enclosures that contain a large inter-individual distance. Even two very compatible individuals may become aggressive towards one another if crowded into a barren space for a long period and subjected repeatedly to additional inescapable stress. These extreme hypothetical cases illustrate that social compatibility exists along a continuum that can vary with other factors. Animals should not be judged

unsocializable on the basis of their behavior under conditions approaching the latter example. Rather, an appropriate physical setting must be provided to accommodate social living.

There is no doubt that successful pair or group housing of primates requires the proper caging and equipment. In order to maximize the potential psychological benefits of social housing and minimize the risks to animal well-being, individuals must have the right kind of space for social adjustments. In addition to the enclosure dimensions that accommodate interaction, the space must be shaped and furnished so that postural and other social signals can be used by the animals to maintain relationships, as in the wild. Caging systems need to be adapted to suit appropriate social grouping rather than the reverse. Resources such as food and water, resting sites, and enrichment devices also need to be chosen and distributed to respect mechanisms for maintaining social relationships.

8. Effects of Human Interaction

Positive interaction with humans can improve the social environment for captive primates (Bayne *et. al.* 1993b, Bloomsmith *et. al.* 1997, K. C. Baker 1997b). Although it should not replace the conspecific social interaction intended by the regulations, positive interaction with humans is valuable in two situations:

- Where conspecific socialization is impossible or detrimental to the animal. In the absence of the mother, a human attachment figure can moderate young chimpanzees' neophobia and enhance coping and exploration responses (Miller *et. al.* 1986). Nonhuman species, such as dogs, may also provide companionship. Another study of infant chimps found that dogs were even more useful enrichment than humans (Pazol and Bloomsmith 1993).

- Where forced contact by human facility personnel is a necessary part of the animals' daily life. Some level of socialization with humans is likely to be necessary to improve psychological well-being because the animals cannot escape contact. Without some socialization to humans, this contact is an environmental stressor over which the animal has no control (Heath 1989, Olfert *et. al.* 1993, Van Vlissingen 1997,)

Many regard a positive, relaxed relationship with human keepers as one of the most important components of captive primate well-being (Poole 1997b, Reinhardt 1997e). Reinhardt warns of potential problems with keepers who appear dominating and intimidating. Those who work with primates must be knowledgeable about primate gestures and vocalizations to avoid inadvertently threatening or stressing primates with their own movements and body language (National Research Council, Institute for Laboratory Animal Research 1998).

The activities and presence of humans may also have significant negative effects on primates. At three chimpanzee breeding facilities, births occurred significantly more often during periods of low human activity (at night and on weekends). This was attributed to the greater privacy and reduced stress during such times (Alford *et. al.* 1992). Line *et. al.* (1989b) found that even routine events like cage cleaning caused elevated heart rates for several hours. On the other hand, Line (1995) also found in another project that study observers had no significant effect on most primate behaviors and that "a period of habituation to an observer...is not always necessary". Thus, unfamiliar humans who must enter a primate area occasionally to make observations, may be able to avoid influencing behavior unduly just by remaining calm and avoiding threatening actions, such as direct stares.

At many facilities, programs of animal training using positive reinforcement techniques have been successful in reducing the stress that normally accompanies manipulations by humans. The cognitive stimulation and pleasurable interaction with humans that such training entails may in itself be enriching (Laule and Desmond 1998). Reinhardt (1997d) collected 46 published reports

on the training of primates to cooperate with clinical and husbandry procedures such as shifting from cage to cage, capture, venipuncture, urine collection, and drug administration. Traditional stressful methods of manual restraint and handling are often unnecessary (Reinhardt *et. al.* 1995a). In only 21 days, Drea (1998) trained a colony of 55 rhesus macaques to repeatedly divide themselves into two groups for a social behavior study. Scott (1990) criticizes training methods using food deprivation. Gifted animal trainers in the film and animal exhibit industry have successfully trained many animals to consistently perform complex tasks, without resorting to water or food deprivation.

9. Periodic or Partial Contact

The social needs of most primates cannot be completely met by single housing. As previously discussed, social primates are very much physical contact animals. Continuous full contact housing, in pairs or appropriately structured social groups allows primates to express sophisticated social adaptations (Jane Goodall Institute 1988, Prince *et. al.* 1989, Visalberghi and Anderson 1993). Walsch *et. al.* (1982) concluded that chimpanzees' "opportunities for visual and auditory contact with conspecifics, in the absence of tactile contact, do not appear to significantly reduce levels of disturbance." In situations where continuous social housing is not appropriate, due to the health or personality of the individual animal or to research protocol requirements, caging allowing periodic full contact or even partial contact with conspecifics can be justified with appropriate supporting evidence (Bayne 1991, Taylor *et. al.* 1998). The more socially restrictive the housing arrangement is, the more rigorously it must be justified.

This does not mean that every individual primate must be forced into social contact. There will be situations where single housing would still be preferable to contact with unsuitable conspecifics. For example, an adult male owl monkey would be more appropriately housed alone, than with another adult male, if that is the only social partner available (Baer 1994).

10. Summary

Companions do not just meet innate social needs in primates. A compatible companion supplies environmental novelty, multi-sensory stimulation, something to manipulate, and opportunities for cognitive challenge and control. Appropriate social enhancement is one of the most versatile and option-laden forms of enhancement we can provide.

B. Social Needs of Infants

Psychological well-being in primates depends on appropriate infant development. Reproductive success (including reproductive behaviors, fertility, prenatal adequacy, parturition, and parental care) is generally considered to be the strongest indicator of psychological well-being in captive nonhuman primates (Novak and Suomi 1991). It is necessary for primate individuals to learn appropriate behaviors to allow them to function in their captive environments. Experiencing effective parenting at an early developmental stage allows the young primate the opportunity to grow into a healthy and responsive adult. The young primate ideally will translate positive early experiences into subsequent social skills, including parenting (Suomi 1986.)

1. Normal Behavioral Development During Infancy

Developmental sequences in young primates may be characterized in the following manner. The neonatal primate is termed an infant until the time it can survive its mother's death. This period encompasses weaning. Infancy is followed by the juvenile stage, which takes the young primate up to the onset of puberty. After puberty, but before reproduction, the primate is considered an adolescent. It must be noted that these definitions are imprecise and are not used consistently across species (Walters 1987).

Infancy in primates is characterized by a variable period of helplessness and dependency. The mother provides nourishment, transportation, protection, and education. The newborn's survival is critically dependent on establishing and maintaining a satisfactory relationship with its mother (W. A. Mason 1986). It must also be recognized, the infant is an active participant in its own postnatal development. W. A. Mason (1971) characterizes the developmental trends in infant primates as a balance between two functional systems: filial ("mother-directed") and exploitative ("other-directed"). Both functional systems exist concurrently in varying degrees throughout the life of the developing primate. As expected, mother-directed behaviors predominate in the neonate: clinging, rooting, and sucking. These behaviors reduce infant arousal and anxiety. This, in turn, enhances the formation of filial attachment. A shift toward exploitative behaviors, such as investigation and play, evolves as the infant develops and interacts with its environment.

Weaning commences as the infant matures. The weaning process consists of two concurrent processes: behavioral weaning and nutritional weaning. Nutritional weaning is completed at the time the infant is no longer dependent on the mother for total provision of food. As the infant grows, the diet is increasingly supplemented with other foods eaten by members of the same species, including insects, fruit, and vegetation. Typically this is a gradual process. Behavioral weaning extends beyond the conclusion of nutritional weaning. This transition encompasses the period during which the infant may nurse, not primarily to obtain food, but to obtain comfort and reassurance during times of stress (Byrne and Suomi 1995, Goodall 1986, Van Roosmalen and Klein 1988). The infant will seek to prolong this period as a means of maintaining the mother-infant bond.

Harvey *et. al.* (1987) have noted the weaning age in primates is strongly correlated with neonatal body weight. Ranges for weaning ages extend from the relatively brief (2 months for some callitrichids) to very long (52 months for some gorillas).

Continuing development in the young primate is influenced by a variety of factors. The age at which an infant will attain independence varies by species. Social structure and group dynamics may play a role in development, depending on species and situation (Milton 1993, Nash 1993, Watts and Pusey 1993). In some species, the presence of alloparents and/or peer conspecifics is essential to promote appropriate development (Worlein and Sackett 1997, Young *et. al.* 1996). Resource availability, such as proper nutrition, adequate usable space, and privacy, may have profound impact on development. The ability to play with others, including parent(s), conspecific peers, or surrogates, enhances the acquisition of locomotor and social skills (Fagen 1993, Fairbanks 1993, Govindarajulu *et. al.* 1993). Individual variations within a species must also be considered: a confident, secure animal may show independent characteristics earlier than a weak, submissive one.

2. Research Findings Related to Development in Captivity

The optimal situation in which any primate should develop is one that permits the infant to remain with its biologic mother through weaning in the company of a species-normal social group (Pazol and Bloomsmith 1993, W. A. Mason 1991,). International Primatological Society (1993) guidelines recommend the young of most species should be allowed to remain in contact with the mother until at least 12-18 months old. Primate Vaccine Evaluation Network (PVEN) guidelines state infants should not be weaned before 6 months and recommend weaning at 12 months old (Poole and Thomas 1995).

Early studies by Harlow and Harlow (1965, 1972) tested the importance of affectional systems in the developing primate by subjecting newborn rhesus macaques to an array of deprivation. Reared in total or partial social isolation, these infant monkeys could not function socially as they matured. They demonstrated inadequate play, social behaviors, and, later, abnormal sexual and maternal behaviors. Other studies by Harlow *et. al.* (1963) showed that motherless infant rhesus monkeys could be reared with more success in peer groups. These monkeys bonded strongly

with each other, as manifested by increased clinging behavior. When the clinging behavior was discouraged, however, the infants exhibited play behaviors which approximated adequate social adjustments. Surrogate studies by Harlow revealed infants separated from their mothers and reared in the presence of various surrogates (inanimate models) exhibited varying degrees of disturbed behaviors. However the degree to which these youngsters displayed aberrant behaviors was less than it was for maternally-deprived infants reared without any surrogate interaction. Other surrogate studies have evaluated the use of simple objects such as shaped wire forms, the complex interactions with conspecific peers in a nursery environment, and interactions with unrelated adults or phylogenetically remote surrogates such as dogs (Pazol and Bloomsmith 1993, Rumbaugh *et. al.* 1989, W. A. Mason and Kenney 1974, W. A. Mason and Capitanio 1988). In general, these studies found the closer the surrogate approaches species-specific maternal nurturing behaviors, the better the infant's chances are to develop adequate and appropriate behavior. No combination of maternal, surrogate, and/or peer contact is quite as effective as the species-typical, mother-peer group in producing completely normal animals. However, for rhesus monkeys, surrogate rearing with daily, but not continuous, contact appears to be the best approximation among the commonly compared regimens (Bayne and Novak 1998, NRC/ILAR 1998).

The response of the infant nonhuman primate to the loss of the mother-figure has been the focus of considerable research effort. These inquiries have sought to elucidate the dynamics of the mother-infant relationship. For the infant, maternal separation or loss is accompanied by a complex series of behavioral and physiological changes. Initially, an agitation/protest phase is observed, characterized by increased locomotion, distress vocalizations, and oral and ingestive behaviors. This phase is followed by a depressive/despair phase, in which the infant becomes increasingly withdrawn and despondent, manifesting reduced locomotion, slouched postures, and diminished interest in play activity. The degree to which an individual infant will exhibit these phases is influenced by a variety of factors: species, age, familiarity with the environment, presence or absence of alloparenting or other social support figures, and intra specific individual variations (Mineka and Suomi 1978, Worlein and Sackett 1997).

In many species, a history of nursery rearing is correlated with various abnormal behaviors in juveniles and adults. These include self-aggression, self-clasping, bizarre postures, rocking, regurgitation with reingestion, locomotor stereotypies, and others (Capitanio 1986, Gould and Bres 1986, Marriner and Drickamer 1994, Platt *et. al.* 1996). In chimpanzees, it is associated especially with body-rocking and self-clasping (Walsch *et. al.* 1982). Spijkerman *et. al.* (1994) found that of various rearing conditions, only rearing by the chimpanzee mother in the presence of peers did not result in development of rocking behaviors. Others found neither human contact nor peer contact were as effective as dogs in mitigating body rocking (Pazol and Bloomsmith 1993).

Infant physiological parameters are also profoundly affected by the disruption of the mother-infant bond. Studies of separated infant squirrel monkeys by C. L. Coe *et. al.* (1985) demonstrated changes in the level of circulating complement proteins and immunoglobulins and decrease in the capacity to mount an antibody response to an antigenic challenge. These findings are supported in other primate species: titi monkeys (Mendoza 1991) and bonnet and pig-tailed macaques (Laudenslager *et. al.* 1990). a study comparing pig-tailed macaques remaining with their mothers for the first 1.5 years of life to pig-tailed macaques separated from their mothers for as little as two weeks during the first year of life showed an association between separation and deficient immune responses in adulthood (Laudenslager *et. al.* 1985). The detrimental immunologic effects of maternal separation in primates can be buffered by allowing the infant to remain in the home cage and providing a familiar companion (C. L. Coe *et. al.* 1987a, Laudenslager and Boccia 1996). Disruption of the maternal-infant bond decreases heart and body temperature, as well as disturbs sleep patterns and EEG activity (Reite *et. al.* 1981). For reviews of the immunologic effects of maternal separation, see C. L. Coe (1993) and Capitanio (1998).

Research efforts have provided much information about negative effects on developmental processes, especially detrimental effects of isolation and early maternal separation. For many species we have an idea of what constitutes lack of well-being. (See Fouts *et. al.* 1989). It is much more difficult to quantify the positive side of well-being. Psychological well-being is not merely the absence of behavioral pathology and abnormality, however defined. It is something positive. But what? We have gained some insight into what situations to avoid when raising primates, but are only beginning to understand the components of a beneficial, species-appropriate environment. Optimal, as opposed to merely adequate, social and nonsocial infant development, is still to be defined.

3. Planning Appropriate Infant Development

A plan to enhance appropriate infant development within a primate population must address many factors. Physical environment is an obvious starting point. First, the plan must ensure that there is adequate space to express species-typical behavior. Both floor space and vertical space must be considered. Increased cage complexities (for example, ropes, swings, and shelves) allow for expression of species-typical locomotor activity and provide opportunities for play. Nesting materials, visual barriers, and refuges can add comfort to an enclosure. Some degree of control over their environment can offset stress in many individuals (Mineka *et. al.* 1986). Provision of manipulanda and the ability to move freely within the existing environment can ameliorate an animal's sense of helplessness and also decrease the level of frustration inherent in some types of captivity.

Social factors are also essential considerations in planning appropriate infant development. Family history, social groupings, age/sex mix, social rankings, individual personality and temperament play important roles, in addition to intrinsic species variations. Witnessing good mothering first hand allows females to observe and learn appropriate nurturing behaviors that they may later apply to their own infants (Miller-Schroeder and Patterson 1989).

To summarize, in most situations, the developing infant's optimal captive environment approximates what it would encounter in the wild, if the natural habitat were undisturbed and risk free. Expression of species-typical behaviors among members of the natal group permits the young primate to learn its role within the culture of its species community. When this structure is provided, infant development can flourish.

Although we have stressed the importance of not disrupting the bond between the infant and its parents or natal group, there are situations in which allowing the infant to remain may also be a source of problems. Cases of infanticide, parental neglect, and abuse of offspring have been noted in both wild and captive environments. Aggression directed toward infants may be perpetrated by family members or unrelated members of the troupe. In captivity, this situation may necessitate removal of the infant from the hostile environment for its own safety. The decision to separate mother and infant introduces a constellation of factors to consider, including: species; health status; age and level of development and independence; availability of foster or surrogate care givers or peer groups; and the feasibility of later re-introductions.

C. Structure and Substrate

The social, developmental, and physical environment are interdependent in enhancing psychological well-being. The most basic components of the physical or inanimate environment are the enclosure structure (its size, shape, and design) and the substrates within it (J. Coe 1989, Maple and Perkins 1996, Poole 1991b). Although the term "substrate" commonly refers to the "base on which an organism lives" and would include flooring, turf, sand, soil, and bedding materials, in this section we include furnishings, perches, swings, ropes, ledges, nest boxes, barrels, culverts, and water features as well. These components should combine to create

opportunities for species-typical resting, exploration, play, and foraging, as well as social interaction and adjustments (Prince *et. al.* 1989, Schapiro *et. al.* 1991, Thompson 1996). The enclosure should allow normal postures and a range of locomotion (Buchanan-Smith 1997, Dahl 1989, EEC 1986, Home Office 1989, International Primatological Society 1993, Marriott *et. al.* 1993, Olfert *et. al.* 1993, Poole 1991b, Poole and Thomas 1995, Poole *et. al.* 1994, Reinhardt 1997b, Snowdon and Savage 1989, Whitney and Wickings 1987).

In order to accommodate species-typical behavior, the enclosure must have adequate space. Use of legal cage size will not always meet an animal's behavioral requirements (NRC/ILAR 1998:18).

Adequate space is not just a question of numeric dimensions or total volume, but also one of shape and design. The space must be structured to be useable and species appropriate. This can be achieved through a variety of furnishings, projections, contours and floor coverings (Chamove and Anderson 1989, Maple and Perkins 1996, NRC/ILAR 1998, Poole 1991b, Schapiro *et. al.* 1991).

1. Resting Behavior

Primates display a variety of different comfort postures during resting and sleeping similar to those of other animals and humans: lying down; sprawling out prone, sternally or laterally; sitting upright; and crouching (Fleagle 1998, McGraw 1998). Vertical clinging is a normal resting, feeding and vigilance posture for many nocturnal prosimians, tarsiers, and callitrichids (Fleagle 1998). There must be something in the cage to which these animals may cling. Squirrel monkeys sleep hunched with their tails curled between their legs and up over their shoulders (Baldwin 1985). According to Abee (1985), large diameter tubular perches provide comfortable, contoured, and stable resting surfaces for squirrel monkeys and prevent the development of pressure sores at the base of the tail associated with the use of flat shelves or boards. Many prosimians, callitrichids, and owl monkeys use nests or cavities for sleeping (Rowe 1996).

In nature, great apes build night and day nests of soft materials. They appear to be painstakingly constructed for comfort (Fruth and Hohmann 1996, Maple and Perkins 1996, Van Lawick-Goodall 1968). While orangutans build their nests only in trees, chimpanzees, bonobos, and gorillas also build them on the ground (Tuttle 1986). Chimpanzee night nests are generally more elaborate than those constructed for day time naps (Van Lawick-Goodall 1968). Chimpanzee nest building skill appears to be learned from elders, with first attempts at eight months of age (Fruth and Hohmann 1994). Human-raised, captive chimpanzees removed from their mothers at birth were unable to construct good nests in adolescence or adult-hood, although some made rudimentary efforts and all manipulated the materials (Bernstein 1962). Suitable materials to facilitate development and expression of nest building include both artificial materials, such as blankets and shredded paper, as well as more naturalistic materials. Even chimps with no prior exposure to nest-construction benefit from these materials as manipulable items (Jane Goodall Institute 1988, K.C. Baker 1997a). Some ape breeding colonies and sanctuaries have provided chimpanzees with elevated "tire hammocks" (tires chained together in clusters), their contour and shape mimicking an arboreal nest.

2. Postures and Tail Positions

In designing enclosures for primates with long tails, one must take into account the position, angle and length of the tail so that it may be unobstructed and held comfortably in a normal manner (NRC/ILAR 1998). Goosen *et. al.* (1984) recommend that for long-tailed macaques, shelves should not be flush against a wall but should have a space between the edge and the wall through which the tail may hang. Poole (1991b) and Reinhardt *et. al.* (1996) demonstrate that many of the standard legal-sized laboratory cages for adult long-tailed macaques, including those

given in the weight-based table of the minimum standards under the Animal Welfare Act, are not tall enough to permit a normal perching posture. Either the animal's head will be obstructed or its tail must be held up to avoid dragging in the waste pan. Cages of this height are inadequate for the "normal postural adjustments" and certainly for the "normal postural adjustments with adequate freedom of movement" required by USDA regulations in 9 CFR Section 3.80(a)(2)(xi). Species with certain anatomical features "might require a taller cage than other species of the same body weight." (NRC/ILAR 1998:26)

As previously discussed, a variety of postures, including tail positions, may be used in social adjustments. An enclosure should have proper dimensions to allow this. Vervets may hold their tails straight out from the body, more than doubling their effective body length while quadrupedal (Estes 1991). New World species use their prehensile tails as a fifth limb (Fleagle 1998). Tail-suspension postures are used in feeding and exploration and for locomotion (Gebo 1992). Prehensile or non-prehensile tails may also be used for support or counterbalance (Baldwin 1985, Fleagle 1998). The Canadian Council on Animal Care (CCAC) Guidelines specify that to engage in normal postures, New World primates with prehensile tails should be provided with linear vertical space about four times the length of their body (Olfert *et. al.* 1993).

All of the apes use their arms and/or feet for suspensory postures. In chimpanzees and gorillas these are more commonly observed in juveniles than in adults (Baldwin 1985, Goodall 1986, Tuttle 1986). An enclosure without properly placed, suitable structures, like bars or hand-holds, cannot enable such postures (NRC/ILAR Report:1998). Bipedal postures, with or without suspensory or tail support, are in the repertoires of many species, including vervets (Estes 1991), spider monkeys (Fleagle 1998), squirrel monkeys (Baldwin 1985), bonobos, and chimpanzees (Tuttle 1986).

3. Locomotion

Locomotor styles vary among taxonomic groups, and most primates exhibit many types of locomotion. Brachiation and other similar forms of suspensory locomotion are seen in the Hylobatidae (gibbons), Atelinae (spider monkeys and wooley monkeys) (Fleagle 1998, Rowe 1996), some colobines (leaf-eating monkeys) (Rowe 1996), and all the great apes (Doran 1996, Estes 1991, Goodall 1986, Tuttle 1986). All primates are climbers, even those that are more terrestrial than arboreal (Chivers 1991, Estes 1991). Terrestrial knuckle walking is specific to gorillas, chimpanzees, and bonobos (Estes 1991). Orangutans walk on the sides of their curled fists (Chivers 1991, Rowe 1996, Tuttle 1986). Floor surfaces for apes in captivity should reflect consideration for comfortable knuckle- or fist-walking.

Ripley (1967) points out that simply classifying a species' locomotor style based on whatever mode that species uses most often does not tell enough about the overall locomotor abilities and patterns of that species. Although rhesus macaques are often simply described as quadrupedal, Dunbar (1989) observed walking, galloping, leaping, climbing, swimming, and even suspension in a free-ranging colony of captive rhesus macaques. The most common running gait was the gallop. Quadrupedal walking and running is exhibited by most primates, either on the ground or in trees. The substrates on which locomotion is most likely to occur differ among species and age classes (Fleagle 1998, Tuttle 1986). Stride lengths of primates are longer than those of most mammals (Reynolds 1987). Some primates are good swimmers, including long-tailed macaques (Rowe 1996), rhesus (Dunbar 1989), and vervets (Estes 1991). This has been put to good use as an enrichment choice for long-tailed macaques in a Canadian toxicology laboratory (Gilbert and Wrenshall 1989).

Leaping is part of the locomotor repertoire of many primates (Fleagle 1998). Callitrichids, colobines and most prosimians are excellent leapers (Estes 1991, Fleagle 1998). Tarsiers leap lengths of three meters (about eight times their body length) from vertical clinging positions. *Presbytis entellis*, the Hanuman langur, routinely leaps horizontal distances of 12 to 15 feet in

trees, and occasionally 35 to 40 feet (Ripley 1967). Given the opportunity, the long-tailed macaque will leap 2.2 meters (Cant 1988). Chimps will leap 10 meters in trees (Estes 1991). In one field study of white-throated capuchins (*Cebus capucinus)*, leaping was 15% of the locomotor time budget, and nearly all leaps were of 1 to 4 body lengths and occasionally seven body lengths. Rarely did they leap less than one body length (Gebo 1992) .

Squirrel monkeys have been described as "incessantly active and manipulative" and showing a "rapid tempo of motor activity"; a study of their movements in a large enclosure showed they traveled over one kilometer per hourly observation session (Fragaszy 1985). In the wild, over 40% of their travel is through leaping, 11% of their locomotion during foraging is leaping (Fleagle 1981). They make frequent leaps of one to two meters in horizontal distance, and sometimes up to seven, with an 8 to 13 meter drop (Baldwin 1985). Several authors have pointed out these forms of normal locomotion are impossible for most primates to execute in standard enclosures of minimum size (Buchanan-Smith 1997, Marriott *et. al.* 1993, Snowdon and Savage 1989). King and Norwood state (1989:104) that for squirrel monkeys in such cages the "opportunity for leaping and sustained quadrupedal locomotion is virtually eliminated."

Similarly, Kessel and Brent (1995a) have pointed out that baboons do not have room to execute normal locomotion and much other species-typical activity in enclosures of the minimum size. A number of facilities have implemented programs of periodically releasing various species of primates into exercise areas to compensate for this.[4] The NRC Report (1998) encourages the use of exercise areas. Other facilities have enlarged the home enclosure with various expansions and attachments.[5] Many of these facilities reported that the exercise areas also served as areas of social contact. Seier and de Lange (1996) found weekly release of vervets into a mobile exercise cage allowed animals to engage in locomotor behavior and socialization not possible in their standard cages and allowed for better assessment of their motor function. King and Norwood (1989) describe how a whole room can easily become an enclosure for a group of squirrel monkeys.

4. Research Findings Related to Enclosure Size and Well-Being

We are not proposing to make any changes in existing cage space requirements already stipulated in the regulations. The body of professional literature relating to psychological well-being of primates is replete with discussions of the possible effects of this environmental factor, especially in combination with other methods of enrichment. Investigating the effects of dimensional space on primate welfare has been controversial and the results equivocal. Kessel and Brent (1995a) and Reinhardt *et. al.* (1996) summarize and critique many such studies. [See also Crockett and Bowden (1994:30), Fouts *et. al.* (1989:381), and Poole and Hubrecht (1994: 51), and Whitney and Wickings (1987:604) for other comments.] Most of these experiments have examined the effects of floor space or volume on physiologic and behavioral measures. The results of most of these were confounded with the effects of social condition (either social restriction or social enhancement), the presence or absence of other enrichment, or rearing history. As both Kessel and Brent (1995a) and Reinhardt (1996) argue, test conditions using barren cages with an absence of adequate enrichment should be viewed as testing under abnormal conditions. They maintain that conclusions about the value of cage size for PWB should only be based on test conditions with otherwise adequate enrichment.

Long-tailed macaques in larger cages had a significantly higher successful pregnancy rate than those in cages with about one quarter of the volume (Boot *et. al.* 1985). Faucheaux *et. al.* (1978) compared effects of enclosure size, rearing history and social housing condition on growth and development of stump-tailed macaques and found animals kept in the smallest cage condition (0.64 square meters by 0.6 meters tall) were lighter and smaller, with noticeable muscle atrophy, than those kept in larger space conditions (23.5 square meters or 450 square meters). Turnquist (1983, 1985) found that housing patas monkeys in small cages had detrimental effects on joint mobility, which could be reversed by release into free-range habitats.

Positive behavioral effects have resulted from exposure to larger and more enriched environments in numerous studies.[6] Many of these involved release into an exercise space or activity cage, while others involved transfer to an enlarged primary enclosure or habitat. A study of common marmoset pairs using five levels of cage size and complexity showed stereotypies were displayed only in smaller cages and levels of aggression and startle response rates were higher in the small cages (Kitchen and Martin 1996).

Conversely, a number of other studies did not demonstrate beneficial effects on behavior and physiology from larger cages (Bayne and McCully 1989, Crockett and Bowden 1994, Crockett *et. al.* 1994, Goosen 1988, Line *et. al.* 1991a, Wilson 1972). Many authors concluded that the value of enclosure space is more dependent on its overall quality than on its quantity alone (Clarke *et. al.* 1982, Erwin 1991, Wilson 1982). Doyle *et. al.* (1996) expanded baboon cages with an attachment which enabled them to equip the cages with enrichment options that could not fit into the original cages. Kessel and Brent (1995a) made a similar point about the need for enclosures to be able to accommodate enrichment items of a size and type appropriate to the species.

5. Special Needs of Older Infants and Juveniles

We must also take into account the special structural needs of older infants and juveniles. The frequency with which juveniles use certain locomotion styles may differ from that of adults of the same species. Young gorillas and chimps engage in more suspensory behavior than adults. In a free-ranging colony of rhesus macaques, arboreal locomotion, occurring primarily during play, was more common among juveniles than among adults (Dunbar 1989). As with social skills, primates must learn motor skills and coordination as infants and juveniles (Fagen 1993, Govindarajulu *et. al.* 1993, O'Neill 1989). Whether particular sensory and motor skills have "critical " periods during development, as with social skills, is unknown.

According to Dunbar (1989:85), the wider ranges of locomotor behavior practiced by older infants and juveniles "provide the greatest opportunity for developing strength, balance, and coordination." In Turnquist's studies (1983, 1985), patas monkeys living in small (30" by 30") cages for five years, developed abnormal joint mobility. The effect was most pronounced among those animals that had begun living in these cages during the first 18 months of their life. The author concluded that "animals born and reared in cages never develop proper muscle tone."

Play is important for young primates (Fagen 1993, O'Neill *et. al.* 1990, Thompson 1996). Pereira *et. al.* (1989b) suggest that the expression of play behavior should be an index of well-being. "Locomotor play is far more vigorous than any normal locomotion" (Jolly 1985:402). Thompson (1996:365) states, "All captive immature animals should be provided with enough space to engage in vigorous locomotor play..." Goosen *et. al.* (1984) maintain that because young primates have a greater need for exercise they should be provided with the same interior cage height as adults of their species.

6. Designing for Arboreality

The most salient factor in structuring a captive primate's environment is the tendency to use vertical space. Primates will make ready use of vertical space and structures such as trees, ropes, cliffs, temple walls, poles, jungle gyms, and enclosure wall mesh (Bayne *et. al.* 1992a, Bennett and Davis 1989, Burt and Plant 1990, Eichberg *et. al.* 1991, Rowe 1996, Shimoji *et. al.* 1993, Suarez 1995). Providing opportunities to fully utilize the vertical dimension is one of the most frequent recommendations for environmental structure made by experts (Abee 1985, Buchanan-Smith 1997, Dukelow and Asakawa 1987, International Primatological Society 1993, Maple and Perkins 1996, Olfert *et. al.* 1993, Poole and Thomas 1995, Poole *et. al.* 1994, Reinhardt *et. al.* 1996, Queyras *et. al.* 1997).

Primates' preferences for the location and position of structures within their enclosures relate to their arboreal habits. Goff *et. al.* (1994) and Traylor-Holzer and Fritz (1985) found chimpanzees used upper levels of enclosures and perimeter areas the most. As previously stated, for groups of Bolivian squirrel monkeys in large enclosures, dominant individuals (females) took the highest available perches and less dominant ones (males) took lower perches (Williams *et. al.* 1988). Woodbeck and Reinhardt (1991) found that rhesus macaques in lower-row laboratory cages used their perches 24.7% more often than those in upper row cages. S. Watson and Shively (1996) observed 12 long-tailed macaques and found that animals in taller cages spent more time in the top third of the cage and exhibited self-directed stereotypies less often than those in shorter cages. Similar preferences for the upper parts of a cage have been displayed by tamarins (Caine *et. al.* 1992) and guenons (Bennett and Davis 1989). The International Primatological Society (IPS) Guidelines (1993) recommend that primates be able to "perch above human eye level." Double-stacked caging systems may force lower-row animals to remain below human eye level (NRC/ILAR 1998).

Primates display "vertical flight reaction". All animals display a minimum "flight distance" through which they will retreat from fear-inducing stimuli (Hediger 1964). Primates generally execute this in the vertical direction when available (Chopra *et. al.* 1992). Primates will be stressed if unable to retreat to this distance from frightening stimuli (Burt and Plant 1990, King and Norwood 1989, Whitney and Wickings 1987). Maple (1979) and Hediger (1964) suggested that enclosure dimensions should be sufficient to contain the normal flight distance. The exact distances will vary depending on the individual and the nature of the threat or stimulus. The 36 to 40 inches of retreat available in most minimum-sized cages for macaques will need to be carefully evaluated. Applebee *et. al.* (1991) designed an enclosure for laboratory stump-tailed macaques that is both tall and deep. However, enclosures should permit humans to capture their inhabitants when necessary. In modest-sized cages that problem can be solved through cage squeeze-back and squeeze-front mechanisms or pole-and-collar restraint systems. In very tall cages, accessibility of animals can be ensured with horizontal dividers and/or animal training (Applebee *et. al.* 1991, Burt and Plant 1990, Reinhardt *et. al.* 1995a). Adequate distances for normal flight response and proper, nonstressful capture and restraint are not mutually exclusive. A primate will become less fearful and more sociable (or "tame") towards its care givers as a result of positive human interaction, and its flight distance will decrease (Heidiger 1968).

For primates on public display, there is no reason not to maintain long distances between the viewing public and the primate. Maple (1979) suggests at least 20 feet of separation in such habitats. In one study, zoo visitors increased aggression and decreased affiliative social behavior in primate groups; the effect was more pronounced for arboreal species (Chamove *et. al.* 1988).

7. Designing Enclosure Furnishings

Perches, shelves, ladders, swings, ropes, barrels, boxes, and other structures can be made of many materials. These can be used for resting, retreating, playing, or staying dry. Wood, plastic, and fiber have the advantage of being non-thermoconductive, which is helpful outdoors on days with extreme temperatures. Cargo nets and large-gauge wire platform baskets are popular in ape enclosures at zoos. Schmidt *et. al.* (1989) and D. Watson (1991) explain methods of equipping standard laboratory cages with perches without interfering with squeeze back mechanisms. Providing perches may be the most inexpensive way to keep primates clean and dry during cage cleaning.

Izard (1991) describes how enclosures for various prosimians were furnished with natural and artificial materials of various sizes and arrangements suited to the species' anatomical characteristics and locomotor and social behavior. This created a network of travel pathways and choices. Vines and bamboo were used in indoor areas and discarded when dirty. Nesting species were provided with nest boxes. Izard comments that wooden furnishings appear to stimulate species-typical scent marking. Substrate diversity and environmental complexity may also affect

the locomotor proficiency of captive golden lion tamarins (Castro *et. al.* 1998, Stafford *et. al.* 1994). Animals living in homogeneous enclosures with large, inflexible, continuous supports exhibited different patterns of locomotion than those in more naturalistic and complex environments with smaller, interrupted, flexible supports.

The kinds of structural items preferred by primates are not easily predicted. Squirrel monkeys preferred rigid perches over non-fixed structures like ropes or swings (Williams *et. al.* 1988). Kopecky and Reinhardt (1991) observed a similar preference in rhesus. Tamarins preferred to use flat surfaces for grooming (Altman *et. al.* 1996). They expressed different forms of play on flat surfaces than on small rounded surfaces (Caine and Boyle 1992). Common marmosets preferred nest boxes with openings facing the room entrance (Kerl and Rothe 1996). Primates of different sexes and ages may prefer different types of structures (Kessel and Brent 1996). Novelty also appears to affect structure use, suggesting some structural items need to be rotated to maintain their enrichment value (Taylor *et. al.* 1997).

Substrates used to cover the enclosure floor can be soft, as are straw, wood wool, shredded paper, wood chips, blankets, vegetation, and soil. These materials can affect space utilization (McKenzie *et. al.* 1986). They may provide comfort, be part of a foraging enrichment strategy, and constitute manipulable items (Westergaard and Munkenbeck-Fragaszy 1985). Hirata *et. al.* (1998) observed two instances of wild chimpanzees using leaves as cushions for sitting on wet ground. The importance of such material for species-typical nest construction in great apes has already been discussed. Many chimpanzee experts consider the provision of bedding material to chimpanzees essential for their comfort (Jane Goodall Institute 1988). Woodchip bedding in outdoor areas for 16 chimps reduced abnormal behavior and helped keep animals dry, without creating any sanitation or health problems (Brent 1992).

When four different types of litter were compared for their effects on the behavior of capuchin monkeys, wood wool and peat proved to be most beneficial at increasing manual foraging and play and decreasing inactivity. Individuals demonstrated a preference for these litter choices. Wood chips were of intermediate value, and they actually avoided corn cob bedding (Ludes and Anderson 1996). Deep litter is used successfully for primate species in many zoos (Dickie 1994). It can be adapted to pharmaceutical laboratory needs (Burt and Plant 1990). Potential health risks associated with these substrates, such as gastrointestinal disorders from ingestion and contamination by pathogens, can be minimized by exercising care in selecting, storing, and handling the materials (Baer 1998b). Drains can be covered indoors and areas spot cleaned rather than hosed daily. Chamove *et. al.* (1982) found after three weeks of use in indoor primate pens, bacterial growth in wood chip litter was actually inhibited.

8. Designing for Social Adjustments

Primate enclosures must nct only be adequate for normal postures and movements of independent individuals, but also must be sufficient for social adjustments. The environment should allow individuals to avoid social threats or other noxious stimuli by maintaining sufficient distance or making use of visual barriers, partitions, privacy areas, and escape routes (Applebee, K. A. and P. E. Marshall *et. al.* 1991, Fouts *et. al.* 1989, Schapiro *et. al.* 1991). Neveu and Deputte (1996) found that, in a group of mangabeys, a reduction in available perches increased social stress and aggression. Bettinger *et. al.* (1994) determined that female chimps in a captive group displayed a preference for opportunities for privacy. Fouts *et. al.* (1989) found that individual chimps preferred different kinds of spaces and parts of the enclosures but their preferences were related to the activities that could take place in them. Other scientists have recommended that captive chimp housing provide opportunities for privacy and have emphasized the importance of small and connecting spaces in addition to larger main areas (Jane Goodall Institute 1988). Rumbaugh (1988) altered the slope of cage fronts to limit violent displays of male chimps towards humans. Bramblett (1989a) emphasizes the value of visual barriers and hiding places for captive guenons. However, in macaque groups certain kinds of visual separation can

be detrimental. Erwin (1979) found that aggression and trauma were worse when a group of pig-tailed macaques had access to two visually separated rooms than when the whole group was confined to a single room. The dominant male, who inhibited aggression, could not see group members when they went into the other room and was therefore unable to control violent outbreaks. This finding confirms how important it is for managers to thoroughly understand their species' social structures and behavior and to carefully assess the effects of new environmental changes.

D. Foraging Opportunities

Foraging is a time-consuming event involving searching for, retrieving or acquiring, and processing food.

1. The Goal of Providing Foraging Opportunities

In the wild, animals spend a significant proportion of their time foraging for food. Wild primates may spend 25% to 90% of their waking hours foraging for and eating food (Clutton-Brock and Harvey 1977). Wild primates also have diverse diets which may include browse, seeds, leaves, flowers, fruits, insects, gum, and animal matter. A review of 46 long-term studies of wild populations showed the percentage of food types in primates' diets (leaves, fruits, insects, etc.) is not consistent from month to month. No correlation was observed between the seasonality of the habitat and the degree of dietary variability. This review indicated dietary variability should be part of a feeding enrichment program (Chapman and Chapman 1990).

To promote psychological well-being, it is not sufficient to merely provide a nutritionally adequate diet. It is important to: (1) increase processing time, (2) stimulate the senses by providing foods other than the typical preformulated pellets, and (3) periodically change the availability of food in time and space.

A primary goal of enrichment programs should be to encourage captive primates to spend more time in foraging, not just in eating. Foraging programs require primates to "work" for food items, spend more time processing foods, and increase their exposure to novel foods. In the wild, "working" for food is one of the most frequently found species-typical and time-consuming behaviors, yet many captive primates are deprived of this stimulation. Foraging differs from treat feeding, where food is handed to a primate. Treat feeding can promote trust and bonding between the primate and caretaker and provide short-term sensory stimulation, but it does not generally occupy a significant amount of the primates' time.

In captivity, the variability of food should be considered as well as its nutritional value. Factors to consider in selecting food items for foraging include their manipulative and processing characteristics (i.e., whether they have shells or husks to be removed), as well as their quantity, color, size, novelty, and ability to stimulate the senses. Foraging enrichment programs can add variety to pelleted diets, encourage animals to express their skills discovering and processing natural foods, and increase the time spent in a species-appropriate activity (Noonan 1998, Schapiro *et. al.* 1996b). Mental stimulation may be provided to animals by requiring them to complete cognitive tasks to obtain their food.

2. Research on Foraging

"Under stimulated animals will readily work for food in the presence of freely accessible food. This indicates the gathering and processing of food are rewarding experiences for them independent of caloric intake" (Reinhardt 1997b:89). Researchers noted a willingness of callitrichids to "work" for their food and an increased range of behaviors displayed. When provided a plastic bowl filled with sawdust and pieces of maltcake, some individually housed marmosets were reported to

forage up to six hours (Scott 1991). In a zoo setting, juvenile patas monkeys would leap several feet in the air to pull off fruit stuck on branches, even when fruit was available on the ground (McGivern 1994).

In a study comparing the value of several different enrichment methods, Bryant *et. al.* found cynomolgous monkeys preferred foraging activities the most (Bryant *et. al.* 1988). When the behavioral profiles of wild squirrel monkeys were compared with those of a captive colony, total foraging manipulations were found to be seven times more common in the wild than in the captive subjects. Five different enrichment devices were then provided to this colony of 16 single-housed squirrel monkeys. The devices manipulated the most, increasing captive foraging times, were a capped PVC pipe with dispenser holes and two liter plastic beverage containers (Boinski *et. al.* 1994).

Captive animals do not have the time-consuming foraging tasks their counterparts in the wild have, and, finding their time unoccupied, may self mutilate, over groom, or become aggressive. Chamove *et. al.* (1982) tested the effect of ground-foraging opportunities on aggression levels in primate groups among six different species. When fruit scattered over the bare floor was covered by wood chips, levels of aggression were significantly reduced among all but the most arboreal species.

Another study--of two long-term stable groups of rhesus macaques (*Macaca mulatta*)--showed when wood chips, monkey chow, and sunflower seeds were used, there were no changes in the occurrence of agonistic behavior. The greatest behavior changes were produced by the scattered sunflower seeds, which increased activity and foraging and decreased passivity and social interaction. The authors speculated the lack of an effect on agonistic behavior and play were probably due to the groups' long-term structure, stability, and low frequency of abnormal behaviors exhibited before the study began (Byrne and Suomi 1991).

When eight individually-housed 7 to 10 year old rhesus macaques were given astroturf-covered boards and allowed to forage for either Crumbles (from Bioserve, Inc.) or broken up monkey chow (NIH Open Formula Extruded Non-Human Primate Diet), they exhibited a significant decrease in repetitive locomotion and stereotypic behaviors. Some of the monkeys had groomed to the point of baldness, and the condition of their coats improved during this study. The total amount of time spent in consumption behaviors increased to 52% when particulate food was made available (Bayne *et. al.* 1992b)

Brent and Long (1995) found that supplying singly housed female baboons with a PVC feeding device and simply giving regular chow more often during the day each reduced abnormal behaviors. The authors recommend a balance of "feeding devices and frequent feedings." But Novak *et. al.* (1998) found that puzzle feeders which required foraging manipulation to obtain supplementary treats were significantly more effective at reducing locomotor stereotypies in single-housed rhesus than treats alone. Unfortunately, these benefits lasted only for as long as monkeys manipulated the device, about 1 hour after filling. Increasing the level of difficulty did not help and caused animals to give up. This suggests that foraging opportunities must be sufficiently time-consuming, but not too difficult, to have a sustained effect. It is important to recognize the crucial difference between time-consuming foraging activity and treat provisioning without associated foraging.

Singly housed yearling rhesus monkeys were provided five different feeding enrichments sequentially during the work day. These enhancements included Astroturf foraging mats, polyvinyl chloride (PVC) foraging trees, acrylic food puzzles, frozen juice cups, and fresh produce. As a result, these monkeys spent significantly more time playing and less time self-grooming than control monkeys did. The behavioral changes observed were species-typical (Schapiro and Bloomsmith 1995).

In another study, when macaques were given fleece pads sprinkled with food crumbles, they foraged for up to 27 minutes an hour, and their stereotypic behaviors decreased by 73%. When the crumbles were consumed, the monkeys continued to use the fleece for grooming (Lam *et. al.* 1991). Agonism has been decreased by foraging enrichment methods that distribute food and reduce the possibility of dominant individuals monopolizing it (Lee 1983, Lutz and Novak 1995, Southwick 1967).

Feeding fibrous browse materials reduces regurgitation/reingestion in gorillas (Gould and Bres 1986) and appears to reduce coprophagy in chimpanzees (Fritz *et. al.* 1992).

A decrease in wasted food is another tangible benefit observed when primates are required to work for their daily rations. During *ad libitum* feeding, up to 50% of the acquired food may be wasted. When foraging, primates eat almost all food they acquire. Cost of setting up foraging enrichment devices may be offset by savings from non-wasted food (Rosenblum and Andrews 1995).

Some enrichment strategies, like use of a deep wood chip litter in the outdoor pen for groups of stump-tailed macaques, have surprising benefits. Odors were found to be less objectionable in enclosures filled with wood chips and cleaned every four weeks than in bare floor runs cleaned every other day. Hours spent cleaning were considerably fewer, and the cleanliness of monkeys' hair coats improved (Chamove and Anderson 1979). Improvements in tail alopecia and coat condition were observed among members of a group of laboratory common marmosets when wooden bases were added to the bottoms of their metal nest boxes and the marmosets were allowed access to shavings in the base trays. With these changes, the cages stayed cleaner and drier (Sainsbury 1990).

3. Specialized Foraging Adaptations of Different Species

When foraging techniques are employed, species characteristics must be considered. Are the primates leaf, gum, insect, or fruit eaters? Are they mainly terrestrial or arboreal foragers? How do they forage? What body positions do they take? How do they use their hands? Do they use tools? Do they tooth scrape for gums? Levels of cognitive ability and manual dexterity vary and will determine what foraging techniques offered are effective.

Primates have a variety of specialized foraging adaptations and preferences. In the wild, ring-tailed lemurs prefer fresh new leaves, while brown lemurs prefer mature leaves. Lemurs do little processing of fruit and chew and lick the end of bananas rather than peel them (Jolly 1985:48). Golden lion tamarins forage mostly by manipulation: sifting, searching for holes, pulling off bark, and breaking open wood. In contrast, cotton-top tamarins are opportunistic foragers, looking for insects in dense branch and vine tangles (Steen 1995). Lorises capture slower moving and generally unpalatable prey, while galagos take more rapid and palatable prey (Charles-Dominique 1977:40).

Patas monkeys were observed to use browse more for bark chewing than for leaf eating and preferred poplar trees (*Populus sp.)* Due to their paw-like hands, patas are more adapted to terrestrial than to arboreal habitats and are less likely to use tools or perform tasks that require manual dexterity. For patas to access the bark on their browse, metal sleeves were used to hold the browse off the floor in a more natural position (McGivern 1994).

Captive squirrel monkeys carefully inspect new surfaces by licking, sniffing, and touching, whereas capuchins explore by persistent manipulation (Fragaszy and Adams-Curtis 1991). Great apes and a few monkey species (capuchins, baboons, and macaques) explore the properties of objects and relate them to one another, a skill that is necessary for tool use. Almost all wild chimpanzees can use tools as a part of foraging, notably for termite or ant fishing and for nut

cracking. Although the other apes and the monkey species listed above rarely use tools in the wild, they readily use them in captivity. Tools and methods for food acquisition can be provided for these captive primates (Tomasello and Call 1997:57-99).

The type of food and where and how it is obtained in the wild needs to be considered when providing food in captivity. Knowing what foods are relished by the species involved can be useful in selecting special treats. Rhesus macaques were trained to urinate inside or on top of an isolation cage in their outdoor pen by use of preferred food reinforcements such as raisins and grapes (Byrne and Suomi 1991).

4. Forage Placement

One method to enrich a captive environment is by manipulating the availability of food in time and space. Foraging opportunities can be presented in a variety of ways, either naturally or with devices. An outdoor environment allows primates to forage in a natural way if food is placed on the ground or in trees as it would be found in nature. This environment can be imitated by scattering food in a foraging substrate (such as wood chips, shavings, straw, hay, leaf litter, or shredded paper) on the bottom of the enclosure. Food hidden throughout the enclosure allows primates to hunt for it. Hidden food items may include fruits, vegetables, seeds, popcorn, cereals, nuts, and raw pasta. Whole fruit or vegetables to be husked, shelled, or peeled by the primate before eating can also be provided. In one study, cage sterotypies were reduced when corn on the cob was offered to singly housed baboons (Bennett and Spector 1989).

Aggression and monopolization by dominant individuals can be prevented in group housing situations by offering food in multiple locations. One zoo study decreased food competition by scatter feeding food treats. In this study, four different feeding methods were presented to groups of monkeys: Diana monkeys (*Cercopithecus diana*), Allen's swamp monkeys (*Cercopithecus nigroviridis*), lion-tailed macaques (*Macaca silenus*), and Hamlyn's monkeys (*Cercopithecus hamlyni*). The group enclosures had indoor and outdoor areas and straw placed on floors and wire roofs. Cut up apples and oranges were scattered on the roof or floor or presented all in one pile on the roof or floor. Comparisons were made of food consumption and rates of acquisition, foraging, and aggression. The time the monkeys spent to acquire their food was found to be the longest when the food was scattered on the roof. The food scattered on the floor took the monkeys the second longest time. The method of presenting food in single piles resulted in some individuals getting little or no food, so this method is discouraged. There were no significant differences in the aggressive interactions that occurred under the four conditions. This study suggests scatter feeding leads to more equitable food distribution, similar rates of acquisition, and increased foraging times (Buchanan-Smith 1995).

At Chester Zoo in the United Kingdom, arboreal species are fed fruits and vegetables on the mesh roof of their cage to mimic spatial distribution of fruit in nature. Roof feeding encourages an increase in a variety of locomotor postures and muscle use, which in turn promotes physical fitness (Britt 1993). When food is presented this way, the primates climb, perch, balance, and hang to retrieve it. Species like woolly monkeys and spider monkeys can then exhibit suspensory foraging postures.

5. Foraging Devices

Foraging devices range from feeder boxes presenting standard primate chow in novel ways to specially designed boards and puzzles for testing the manipulative and cognitive skills of the species. When standard feeder boxes were remounted onto the square mesh (22 X 22 mm) of the front of cages, individual rhesus macaques took an average of 18.3 minutes to extract the biscuits, compared to 0.2 minutes to collect the biscuits from regular box feeders (Reinhardt 1993a). A foraging device presented to singly-housed cynomologous macaques was preferred

over the standard hopper style feeder, and self-directed behaviors were significantly reduced over baseline values. Using it with novel foods and as part of a rotation program renewed interest in the device (Holmes *et. al.* 1995). Distributing group housed macaques' daily standard biscuit ration on top of their chain-link ceiling enclosure increased their foraging time more than 50 fold over putting it in feeder boxes (Reinhardt 1997b).

Astroturf can be attached to boards or hanging logs (Bollen 1995), and small food items such as raisins and seeds stuck into it for the primates to extract. More complex foraging devices have been invented and shown to be useful in occupying primates' time and interest. These include acrylic food puzzles (Schapiro *et. al.* 1991), various shaker boxes and toys, and peg boards placed outside enclosures where food has to be manipulated with "tools" to pull it through the peg maze.

Foraging devices can be made more complex by suspending them from the ceiling. The movement of these hanging devices is especially unpredictable when two primates use them simultaneously (Buchanan-Smith 1997). A challenge was presented to spot-nosed guenons and white-faced capuchins by placing food treats in a free-spinning feeder log hung on a wire out of easy reach (Dorian 1993).

Other novel ways to present food treats include: pine cones stuffed with peanut butter and raisins, juices frozen in cups or ice cube trays, seed and flour paste painted on walls and other objects, fruits and vegetables frozen or speared and hung on bamboo canes. Food may also be scattered in the bottom of pools of water or hidden in cardboard rolls stuffed with shredded paper.

As is the case with other types of enrichment strategies, different species, age groups, and individuals may prefer different types of foraging devices (C. Watson 1997). Not all foraging devices are effective in a given situation (Lutz and Farrow 1996), and facilities may need to try several methods.

6. Foraging for Insects

Live insects also give primates a chance to work for their food. Live prey allows primates to stalk, grab, poke, and pry for their food. Live prey can include beetles, caterpillars, moths, grasshoppers, locusts, ants, crickets, mealworms, butterflies, centipedes, millipedes, spiders, slugs, snails, and frogs. Due to potential health concerns, most captive primates are fed only crickets and mealworms for insect prey. These can be obtained from commercial breeders. Live goldfish in fishing pools have been used as prey for some species such as squirrel monkeys (King and Norwood 1989).

McKenzie *et. al.* discovered captive cotton-top tamarins (*Saguinus oedipus)* made few visits to the cement floor of their enclosure until it was deeply covered with wood chips and scattered with grains and insects. Unlike their wild counterparts, the mostly arboreal primates easily learned to use the ground when given a reason to do so (McKenzie *et. al.* 1986). Although the ground foraging is not a species-typical behavior, the insect feeding is (Rowe 1996:75).

Insects such as crickets or mealworms can be provided in either passive or active dispensers. Passive dispensers such as PVC pipes or milk jugs with small holes in them can be hung from enclosure ceilings or walls to allow slow dispersal of the live prey. Active dispensers require the primate to work to obtain the prey. The PVC or bamboo devices have holes sized so the primate can reach in with a finger, hand, or arm and retrieve prey hidden in the bran, sawdust, or similar materials inside it. Active dispensers can also be used with other food items (Banchero 1995, Demlong 1993, Glick-Bauer 1997, Steen 1995, Wassel and Race 1994).

7. Gum Feeding

Exudate or gum feeding occurs in 45 species of animals, including prosimians, marmosets, tamarins, and Old World monkeys (Kelly 1993). The specialized diets of these primates need to be considered and a similar eating method provided. Gum arabic is an ingredient in many food products, including bakery, confectionery, dairy, and frozen dessert products. Commercial sources of gum arabic (from *Acacia senegal*) are available. The gum mixture can be presented in free-hanging liquid dispensers, holes drilled in branches, logs, or trees, or specially made dowels (Brennan and Russel 1986, LeBlanc 1993). Besides providing enrichment and enhancing visitor viewing, gum-feeders benefit marmosets by increasing their level of activity and visibility for head counts and health observations, and the acceptability of medications mixed with gum and given by syringe (Kelly 1993).

8. Water

Water can be useful as part of an enrichment technique. Wild primates obtain water by mouth, by cupping it in their hands, or by using leaves as sponges. Besides drinking it, they use water in other ways. Japanese macaques were observed submerging potatoes and grains to remove sand and grit (Itani and Nishimura 1973). Several species of macaques dive and swim to obtain food (Malik and Southwick 1988, Suzuki 1965). Standing and running water elicited a broad range of species-typical behavior in group housed rhesus macaques. Females exhibited tool use, and many of the primates soaked their primate chow in the water before eating it. Almost all the macaques also used the water trough as a secondary drinking source. Use of a water trough proved to be a novel, simple, and inexpensive enrichment technique (Parks and Novak 1993).

9. Browse

Fresh browse is a great source of natural enrichment. The National Zoo has a list of approved East Coast browse species they feed to their animals. These include: alder, amaranths, arborvitae, aspen, bamboo, beech, birch, bush honeysuckle, butterfly bush, cattails, chicory, clover, comfrey, cotoneaster, cottonwood, daylily, dogwood, elaeagnus, elm, fig, forsythia, grasses, greenbriers, hackberry, hawthorn, hazelnut, hibiscus, Japanese silver grass, kerria, kudzu, linden, maple (except red maple), mock orange, mulberry, nasturtium, Oregon grape holly, pear, pickerelweed, poplar (except tulip poplar), purslane, raspberry and blackberry, redbud, rose, snowberry, violets, water hyacinth, and willow (Shumaker 1995).

An herb garden was provided to woolly monkeys housed outdoors in a zoo (Vermeer 1994). Herbs were grown in a wood box covered with wire mesh. Roots were protected by allowing the monkeys to access only plant parts growing above the mesh. Species of herbs were chosen which had medicinal compounds effective against the typical health problems of these monkeys. In addition to treating potential illness and stress, the herbs provided variation in taste and diet. Insects were attracted to the flowers of the herbs and provided additional dietary variety. Other monkeys who showed an interest in the herb gardens included sakis, marmosets, tamarins, capuchins, lemurs, and squirrel monkeys.

In a study of six chimpanzee groups at three different sites, 13 plant species were identified as being used for their medicinal value. Chimpanzees chew the pith of plants, swallow whole leaves, and eat other items of possible medicinal value such as bark, wood, termite mound clay, and saponin-rich berries. Often these food items are extremely bitter and even toxic in certain amounts. The value of these plants is believed to be related to control of parasites and gastrointestinal disorders, regulation of fertility, and possible antibacterial or antihepatotoxic activity (Huffman and Wrangham 1994).

10. Other Considerations

Since there may be striking individual preferences for different foods, various foraging items should be tried even if they are not usually given to members of that species. However, some precautions are needed for using food as environmental enrichment. Because extra food over the normal diet could result in obesity, weights may have to be monitored, and amounts fed adjusted. Increasing the level of difficulty too much in a foraging program may cause distress and will not necessarily increase foraging behavior (Novak *et. al.* 1998). All aspects of an enrichment program, including foraging strategies, need to be evaluated on a continual basis to address any potential problems and make necessary adjustments.

E. Manipulanda

Manipulanda are objects that can be moved, used or altered in some manner by the primate's hands. Monkeys and apes readily handle a variety of objects during play, display, grooming, and sexual behavior (Schapiro *et. al.* 1991:22). Primates often choose to manipulate items with their mouths as well as their hands. The items may be artificial or natural. They may be durable or easily broken, taken apart, destroyed, shredded, or used up. "Toys" such as balls, chew toys, etc., immediately come to mind in this category, but other objects associated with food, bedding, or moveable structures also qualify as manipulanda. Also included are mechanical devices such as electronic game machines which primates learn to use. Some of these even permit interaction with caretakers and the public (Markowitz 1981).

Primates have excellent dexterity, which they combine with advanced intelligence to solve problems. Some species, such as capuchins and great apes, are extremely dextrous, others have limitations due to anatomical and behavioral differences (Visalberghi 1990, Westergaard and Munkenbeck-Fragaszy 1985). Tool use, once thought to be unique to humans, has been documented among wild and captive primates (Beck 1980, Chevalier-Skolnikoff 1990, Phillips 1998, Starin 1990,). Sugiyama (1995) describes chimpanzees using different leaf species as spoons or sponges to drink water or sap. Captive mustached guenons (*Cercopithecus cephus)* may use an oat straw as a grooming tool (Maxwell 1993). Toys and other objects to manipulate are excellent forms of enrichments. These items must be chosen wisely to suit the species involved.

Examples of manipulanda are:

- Large, moveable objects such as bowling pins, highway cones, buckets, milk crates, and barrels
- Medium sized semi-durable items such as PVC joints and plastic containers (jugs and bottles)
- Small, rubber and plastic balls, rings, chains, and squeeze toys
- Rawhide and soft rubber chews
- Frozen items (ice cubes, fruit juices, fruits and vegetables) and ice blocks with items in them
- Soft cloth items such as stuffed animals, blankets, sheets, and burlap sacks
- Wooden branches, twigs, browse, dowels, and blocks
- Paper and paper products (bags, butcher paper, newspapers, magazines, and telephone directories)
- Cardboard products such as carpet and towel tubes and boxes stuffed with shredded paper.

When toys are new they stimulate curiosity and may increase play behavior. Animals, however, lose interest in or habituate to toys over time (Cardinal and Kent 1998, Paquette and Prescott

1988, Taylor *et. al.* 1997). Rotating toys on the basis of texture, shape, and color helps to maintain interest (*NRC/IILAR* 1998:17).

Enrichment techniques can be used to target a variety of species-typical behaviors and activities. Hiding fruit in a cardboard roll stuffed with shredded paper stimulates exploration and increases processing time. The cardboard roll can be manipulated and played with following food retrieval (Banchero 1995). The goal of providing manipulanda is to increase the time that a primate is engaged in manipulatory behaviors similar to those exhibited in the wild.

Manipulable objects have been effective in increasing species-appropriate behavior and decreasing abnormal behavior in many instances (Bayne *et. al.* 1992a, Brent and Belik 1997, A. S. Clarke *et. al.* 1982, Eaton *et. al.* 1993, Kessel and Brent 1998a, Westergaard and Munkenbeck-Fragaszy 1985). In some cases, they have not been effective (Line *et. al.* 1991b, Spring *et. al.* 1997). Not all items are equally interesting to a primate (Brent and Stone 1996, Bryant *et. al.* 1988, Cardinal and Kent 1998).

Wilson's 1992 study of captive great apes showed the importance of customizing objects for the species using them (S. Wilson 1992). Young gorillas often used objects such as browse or toys to interact with other animals. In a typical interaction, they would give another animal a playful swat with a branch and run. Orangutans on the other hand preferred to manipulate burlap sacks, boxes, or hay while remaining in one position. The gorillas appeared more active than the orangutans and chose objects they could easily carry with them. Wilson also concluded the number of animals within the enclosure played a large part in determining how active the animals were.

Having objects to manipulate may be particularly important for primates that are socially restricted (Boinski *et. al.* 1999, Crockett *et. al.* 1989, Eaton *et. al.* 1993). Schapiro and colleagues found singly-housed rhesus macaques used inanimate enrichment more than rhesus living in social groups (Schapiro *et. al.* 1996a, 1997a). However, Novak *et. al.* (1993) found older, socially housed rhesus also used toys quite frequently. [Also see Line *et.al* (1991b) on this subject.] Toys reduced abnormal behavior in group-housed baboons (Brent and Belik 1997) and single-housed pig-tailed macaques (Kessel and Brent 1998a). However, for chimpanzees, Brent and Stone (1996) found social housing had no effect on object use. Dominance status may also play a role in whether a primate will use an object (Novak *et. al.* 1993).

Most objects are designed to stay inside the enclosure, but some hang on the outside. Some objects are meant to be indestructible, however many primates are motivated to destroy them. Some objects are provided with the intent they be shredded or chewed (Pruetz and Bloomsmith 1992).

As with human children, care must be taken to ensure objects given to primates are reasonably safe for the species: that they cannot injure their hands on them; that they do not chew and swallow harmful amounts of them (if they are inedible); that they do not become inescapably entangled in them (as with a long chain) (Murchison 1993). Some types of manipulanda must be periodically cleaned or removed. The amount of labor involved and the costs vary. The benefits to the animals must be weighed against the costs and potential risks. "Straw and burlap bedding, cargo nets, and destructible (and edible) objects can be injurious to animals, but if they are carefully selected and the animals frequently observed, we believe that the benefits of many of these types of objects outweigh their potential harm" (*NRC/LAR* 1998:17).

It is important for an animal to feel that it has some control over its environment (Markowitz and Aday 1998). This could be one reason why simple, destructible objects are often preferred by primates over more complex indestructible ones (Bryant *et. al.* 1988, Sambrook and Buchanan-Smith 1997). Kessel and Brent (1998) also suggest providing multiple objects is a way to increase

choice and control. Multiple objects in social groups also help ensure dominant animals cannot monopolize the objects.

It is also important the animal has the ability to escape from the object if threatened by it. Sometimes a novel object or situation will evoke "neophobia" or fear in a primate. Careful consideration of species, age, rearing history and other individual characteristics in choosing objects will reduce the likelihood of fear reactions.

The Wisconsin Gnawing Stick is a low cost enrichment item for caged macaques. This branched piece of deciduous tree offers the primate many options. Macaques were observed manipulating, gnawing, nibbling, chewing, hugging, dragging, rolling, playing, and even perching on it. Such activity causes the object to change shape, size, and even texture over time, and thus maintain its novelty and counteract boredom (Reinhardt 1997c).

Manipulanda as a critical element overlaps with two others--structure and substrate in the primates' enclosure and providing foraging opportunities. Manipulable objects play a role in social interactions that must be carefully understood. They also play a small role in permitting infants to develop properly. However, the most important aspect of manipulanda may be that, if selected and used well, they can stimulate several senses and permit the animal to experience novelty and a sense of control over part of its environment.

F. Consideration of Sensory Stimulation

In designing a plan to meet the five critical elements, a facility must also consider stimulation of the five senses, including the visual, auditory, olfactory, tactile and gustatory senses. For example, in choosing housing options under the critical element of Social Grouping, the facility should recognize that permitting primates to live together and communicate with each other provides them with stimulation of most of the senses. Social housing of primates is a rich source of sensory stimulation and should be accomplished whenever possible. If social housing with contact with others of their species is not possible, it is important to provide as much sensory contact as possible, whether it be seeing, hearing, or smelling other primates. The importance of the senses and other methods of providing sensory stimulation are discussed below.

1. Visual

Visual communication is a major source of information between primates. Spacing between individuals, body postures, and facial signals, especially the complex facial signals in hairless-faced monkeys and apes, all convey information. Primate social relations are maintained and changed through the use of visual communication. Visual communications can be analyzed to determine how to manage social relationships (Zeller 1987). Caregivers need to be aware of the importance of visual communication when group housing primates or when arranging single-housing caging.

Large, complex environments with complete social groups offer a rich variety of visual stimulation. Visual stimuli are virtually negligible in small, barren, isolated environments with limited views. Outdoor environments provide natural stimulation from the weather, vegetation, and passing wildlife.

Animals may need temporary visual seclusion as well as stimulation (Bramblett 1989b). The optimum types and levels of stimulation vary between species and individuals. Additional enrichment may be provided by allowing the primate a means of controlling the stimulation (J. Coe 1995).

Many methods of enriching the environment visually involve the use of light, color and motion. Standard stainless steel cages may be altered to provide more light and enable visualization of neighboring primates by replacing bars or metal walls between cages with clear plexiglass panels. It is also helpful to redesign rooms so primates are not kept in darkened, lower-tier cages (Mahoney 1992, Reinhardt 1997c). Giving nocturnal species such as *Aotus* sp. red or blue lights rather than total darkness during the reverse dark cycle promotes their normal activity levels (Wright *et. al.* 1989). Simulating dawn and dusk by gradually turning on or off the lights is also beneficial.

Color schemes in animal rooms may enrich the environment for both monkeys and human caretakers. Lights of varying colors have been found to affect chimpanzees' behavior. For instance, cool-spectrum light (green) reduced the incidence of anxiety behaviors such as pacing and rocking (Fritz *et. al.* 1997). Sunlight has more ultraviolet radiation than fluorescent light, and there is a peak in the blue-green rather than in the yellow-green region of the visible spectrum. It may produce positive effects similar to those described for the chimpanzees (Thorington 1985). When color dyes were added to dry primate chow and presented to adult and juvenile orangutans, the juveniles consumed more food than previously, and the adults consumed their food in less time. One juvenile showed a definite preference for red chow (Barbiers 1985). Colored objects to manipulate may provide some visual stimulation, especially if they have moveable parts.

Motion can be used as visual stimulation in various forms such as TV, videos, or video games (Brent and Stone 1996, Rumbaugh *et. al.* 1989). Television should only be presented in a way that primates have the choice not to watch it, as some television images may be disturbing.

Several studies have evaluated the ability of audiovisual and computer media to increase the complexity of the environment, especially for singly-caged primates. In one study, the time chimpanzees spent watching videos varied with the content of the tape and with individual preferences (Bloomsmith and Young 1988). Chimpanzees who observed "real" world events on TV seemed to understand the TV monitor (Rumbaugh *et. al.* 1989). Chimpanzees have demonstrated they can learn to use a joystick by watching an experimenter play a game. They have also learned about food locations and events occurring outside their direct view by watching television monitors (Savage-Rumbaugh 1986).

Rhesus macaques have also been found to watch videos and manipulate video game joysticks. They spent more time watching videos than manipulating joysticks. Females showed more interest than males. Both socially and individually housed monkeys became more active (Platt and Novak 1997). Although it did not help as much as puzzle feeders and foraging boxes, short-term viewing of videotapes did decrease some stereotypic behaviors in rhesus with abnormal behaviors (Meunier *et. al.* 1989:479). One study seemed to show videotapes were not as effective as sensory stimulation, but the videotapes used were presented without sound to yearling rhesus housed singly outdoors where they could watch other monkeys and had competing stimuli from the natural environment (Schapiro and Bloomsmith 1995). Rhesus' psychomotor skills and cognitive abilities are often tested with the use of joysticks and computer screen programs. One psychomotor test system consisted of a computer game with a food reward. Monkeys are given free choice to access the game or not. This allowed them to interact with and exert some control over their environment. In experimental protocols related to grading induced Parkinsonian symptoms, test systems such as these are used to determine abnormal psychomotor performance (Rosenberg *et. al.* 1990).

Mirrors have been used in many ways. Some monkeys can perceive a mirror image as their own reflection (Platt and Thompson 1985). They can skillfully direct mirrors toward an otherwise visually unavailable activity or animal (Eglash and Snowdon 1983, O'Neill-Wagner *et. al.* 1997). Small portable mirrors are repeatedly manipulated and remain a source of fascination over a period of months (Anderson 1983).

2. Auditory

Auditory stimuli consist of vocalizations from other primates, sounds from the natural environment, and music. Vocalizations can communicate messages such as danger, fear, and discovery of food, and are important signaling mechanisms between primates (Bayne 1995). Auditory calls are especially important when visual transmission of messages is not possible. Lar gibbons signal territorial ownership by "singing". This singing behavior may also be important to the formation and maintenance of the pair bond (Shepherdson *et. al.* no date). Primate species who practice allomothering have specific play vocalizations which may serve as information sources for maternal retrieval of infants (Masataka and Kohda 1988).

Because vocalizations are an integral part of many species' social structure, they are sometimes used as quantitative indicators of group members' psychological health. A study of three individually housed olive baboons compared animals' vocalizations in enriched and nonenriched environments. When enrichment items were present, there was an increase in the number of certain kinds of grunts believed to be a means to maintain contact. It is possible caretakers can learn to use vocal signals to evaluate animal welfare (Crowell Comuzzie 1993).

Acoustical recordings of primate vocalizations, made continuously or at discrete times, show there are different frequencies and types of vocalizations made in response to various kinds of behavioral and environmental events. Many animals exhibit different vocal patterns depending on their emotional states. Animals also make nonvocal sounds, such as cage-banging, to express their emotions. Rhesus macaques were shown to begin moving vigorously in their cages and emitting anticipatory "coos" in response to the sound of outside footsteps. Wild rhesus give similar "coos" of different intensities to signal excitement or relief. Studying these vocalizations may provide a way to assess the monkeys' emotional states (Mulligan *et. al.* 1994).

Music and naturalistic sounds available at times throughout the day may reduce aberrant behaviors (National Institutes of Health 1991). Socially housed rhesus monkeys given access to a device allowing them to turn music on and off spent a considerable amount of time playing the music. Their interest was maintained longer when they were given a choice between two stimuli, and they showed a preference for jazz and dixieland over animal sounds. Compared to a control group, the rhesus given auditory stimulation showed an increase in affiliative behavior and a decrease in self-directed behaviors. The study also showed the music had a calming effect during conditions of heightened arousal such as the introduction of a novel or threatening object (Drewson 1989). Although the behavior and blood pressure of a small group of singly caged baboons did not vary when they were given auditory stimulation, their heart rates were significantly lower when the radio was on (Brent and Weaver 1996).

Under certain conditions, auditory stimulation can be aversive and turn into noise. Individually housed monkeys in colony rooms sometimes raise the sound levels quite high. Loud noise has been frequently reported to cause abnormal behavioral and physiological effects (Gamble 1982, Peterson 1980). Sudden unexpected noise can also be disturbing and should be minimized (International Primatological Society 1993). Pregnant rhesus monkeys exposed to unpredictable noise during mid to late gestation had offspring that showed more abnormal social behavior than those in a control group (Clarke and Schneider 1993). High noise levels resulted in sustained blood pressure elevations in rhesus monkeys (Peterson *et. al.* 1984). Primates who could control the volume of loud, continuous white noise showed less stress than animals who could not control it (Hansen *et. al.* 1976). Auditory stimulation seems to be most beneficial when the monkey has some control over it.

3. Tactile

Tactile stimulation is provided by all aspects of a primate's environment, including the materials composing the cage, items placed in the cage such as food and toys , and cage mates. In outdoor enclosures the sense of touch is stimulated by environmental factors such as the sun, rain, and wind.

Group housed primates receive much tactile stimulation when grooming their cage mates. If primates cannot be group-housed so they are together all the time, tactile contact should be allowed with conspecifics or caretakers on a periodic or scheduled basis or through grooming bars (Crockett *et. al.* 1997, Taylor *et. al.* 1998). Macaques who received fleece cushions groomed them using the same motor patterns directed toward monkeys. The fleece pads, with and without forage crumbles, reduced stereotypies by up to 73%. These researchers "strongly recommend provision of separate grooming and foraging substrates" for single housed monkeys (Lam *et. al.* 1991). Tactile stimulation is especially important to infants. Cloth-covered objects are used to provide tactile comfort to surrogate-reared infants.

Physical contact between conspecifics has other psychological benefits. If wild chimpanzees are frightened by an unaccustomed sound, they usually seek physical contact with companions, touching, embracing, or kissing (Goodall 1986). The same calming effect of physical contact is seen with captive chimpanzees (W. A. Mason 1965).

Grooming can be used in operant conditioning as a positive reinforcer. In a study of visual discrimination, when a monkey correctly indicated a pattern, the experimenter groomed the monkey's face, neck, and head with his hand (Taira and Rolls 1996). In research involving 10 coprophagic chimpanzees, treatment consisted of stimulating the tactile senses through the use of various paper media, a combing/brushing schedule, and muscle pressure techniques. The rate of coprophagia was observed to decrease (Struthers 1997).

A floor substrate such as woodchip litter, straw, or leaves provides tactile stimulation to primates when they search through it for hidden food items (Chamove and Anderson 1979, K. C. Baker 1997a, Stegenga 1993). Manipulating artificial turf or fleece as part of a foraging task provides tactile stimulation.

Food has various sense-stimulating properties, including tactile. Whole food manipulation may be an important part of an animal's feeding behavior, but a common practice is to chop food into small portions and distribute it equally among individual animals. In a study in which lion-tailed macaques were given eight different whole or chopped foods, time spent feeding increased when food was presented whole. Unexpected positive results of presenting food whole included: the mean diversity of foods consumed was greater, and total food consumption increased (Lindburg and Smith 1988).

4. Olfactory

Anatomical specializations for olfactory communication are most common among the prosimians, callitrichids, and some Cebidae. Specialized glands in these primates produce volatile, strong-smelling chemicals called pheromones. When individuals scent mark they actively or passively transfer pheromones to objects or locations in their environment to signal their presence. Another type of olfactory signaling is urine washing, where the primate urinates on its tail and feet so these leave a scent trail.

Olfactory communication is used for territorial defense, to foster aggregation of group members, and to signal alarm or aggression (Zeller 1987). In some species, scents indicate not only species and gender, but also individual identities (Epple *et. al.* 1988). One study showed discrimination of

predator and non-predator scents is innate in cotton-top tamarins. This underscores the importance of not placing predators and their feces where prey species can smell them (Buchanan-Smith *et. al.* 1993).

Olfactory stimulation is essential for the psychological well-being of scent marking species, and objects must be provided which allow them to mark their environment. Over-cleaning their enclosures needs to be avoided to prevent behavioral problems and skin lesions resulting from an over-stimulated need to scent mark (NRC/ILAR 1998).

Many primates benefit from being provided foods with a variety of different scents. One method of olfactory stimulation is to prepare popcorn in primates' rooms.

The possibility that colognes, perfumes, and other scented items might have potentially negatively effects should be considered. In one such incident, the first time a zoo keeper wore perfume to work she was bitten by a black and white ruffed lemur (*Varecia vari*). In another zoo, a visitor who used an herbal shampoo had a group of ring-tailed lemurs (*Lemur catta*) jump on her shoulders and begin grooming her hair (W. K. Baker 1997).

5. Gustatory

Although most people consider taste foremost in their food selections, many captive primates are not given much gustatory variety or choice. They are routinely fed diets consisting of commercial monkey biscuits and occasional pieces of fruit. This is an extreme contrast to their natural environment. Fruits compose 60 to 90% of the food intake of wild macaques, and macaques may consume over 100 or more plant species in a year (Lindburg 1991). Wild chimpanzee diets are extremely diverse, consisting of fruit, leaves, stems seeds, other plant parts, animal matter, and inorganic matter (earth, ash, rotten wood). The relative lack of diversity in captive primates' diets restricts their experience of different tastes, textures, consistencies, sizes, and colors of food items. Increasing the variety of a captive diet is the simplest way to increase the variety of sensory characteristics of food (Bloomsmith 1989a).

A project at Duke University Primate Center showed leaves from a number of local plants can be substituted with no adverse effects for the mango leaves sifakas normally eat. The lemurs and sifakas exhibited plant species preferences and seasonal preferences in the plant parts (Pereira *et. al.* 1989b).

Studies have demonstrated that mammalian species have profound differences in their sense of taste. The sweet tasting ability has been the most studied and differs among primate species. Frugivorous species often have high sensitivity to sweetness and may use it as a criterion in food selection (Hellekant and Danilova 1996, Laska 1996, Laska *et. al.* 1996, Pritchard *et. al.* 1994). Species preferences need to be considered in providing gustatory variety.

6. Environments: Natural vs. Artificial, Outdoor vs. Indoor

Few people would argue that natural outdoor environments provide primates with more sensory enrichment opportunities than indoor ones. Outdoor environments provide stimuli caused by weather changes and the sights, smells, and sounds of insects, amphibians, birds, and other animals.

Many primate programs try to create a naturalistic environment indoors with various substrates. The Duke University Primate Center showed for some lemur species even large indoor rooms with naturalistic substrates proved inadequate to promote normal behavior. Reproduction and activity patterns improved when sifakas were provided outdoor space. When given the choice of a

large indoor room or a much smaller outdoor extension, the sifakas spent 90% of their time outdoors (Pereira 1991).

One study was conducted to test whether laboratory born and raised rhesus juveniles could benefit from short-term exposure to an outdoor, apparatus-enriched corncrib enclosure next to a semiwooded pasture. During the nine weeks they were outside, they achieved higher scores for locomotion and exploration. They also exhibited less frequent self-oral behavior, a change which remained when they returned to the laboratory environment (O'Neill *et. al.* 1991).

7. Stimulus Poor Environments

Many captive environments contain much less stimulus variety than the natural environment. Environmental enrichment may be of greater importance to primates confined to indoor, stimulus-poor rooms than to those that can go outdoors (Schapiro and Bloomsmith 1995). Sensory deprivation may cause repetitive movement which "can be seen as an animal's attempt to increase its sensory input" (Wemelsfelder 1985: 143). Chamove and Anderson (1989) have suggested that stereoptyped movements, being familiar and repetitive, can also calm an individual when sensory input is too high."

8. Levels of Stimulation--Controlling Exposure

All primates need to be carefully observed to assess how various stimuli affect them. Caretakers can be a major source of stimulation for individually housed primates, but caretakers' mannerisms, voice patterns, and timing of visits may calm or stress these primates (Cooper and Markowitz 1979).

A basic behavioral need for any primate is to have some choice over the stimuli in its environment. Several zoos are now designing group-living enclosures with gradients of environmental choices. Smaller animal enclosures could be equipped with motion detection activation controls to allow primates to exercise choices over conditions such as light intensities, colors, and sound recordings. Options like these compose the next level of enrichment, allowing animals some environmental control (J. Coe 1995).

G. Consideration of Novelty and Control

In designing a plan to meet the five critical elements, a facility must also consider the need to provide the animals with some degree of novelty and control over their environment.

The concept of providing novel objects in promoting psychological well-being of nonhuman primates is an accepted practice (Adams *et. al.* 1992, Bayne *et. al.* 1993a, Bloomsmith *et. al.* 1990, Bryant *et. al.* 1988, Chamove and Anderson 1989, Chmiel and Noonan 1996, Line and Morgan 1991, Line *et. al* .1989a, Preutz and Bloomsmith 1992, Shefferly *et. al.* 1993). Novel objects provide opportunities for animals to interact, use species appropriate behaviors, and expand their captive behavioral repertoire. The use of novel objects has been shown to replace or have therapeutic effects on the abnormal behaviors of caged primates (Bloom and Cook 1989, Line *et. al.* 1989a, Reinhardt 1989).

Novel objects are those which have a relatively high degree of unpredictability to the animal in that many, if not all, of the properties are unknown to it. Objects are usually classified within a range between extremely novel and totally familiar. The more properties of an object that are known to the animal (predictable by it), the less novelty is inherent in the object. Predictability at moderate levels can be beneficial to caged nonhuman primates, but high levels of predictability

are considered to be boring. At the other extreme, a high degree of unpredictability may result in extreme stress (Fragaszy and Adams-Curtis 1991, Sambrook and Buchanan-Smith 1997).

When applied generally to enrichment devices and strategies, novelty is variation sufficient to maintain a moderate degree of unpredictability. The variation may be in physical properties such as the size, location, or composition of something, or in the timing or duration that a novel situation is presented. The pelleted food commonly provided to laboratory monkeys is not novel if provided in the accustomed way. However, it may be considered novel if the food is provided in an unusual location and receptacle, such as in a hanging basket the monkeys must swing and reach into, or in small, hidden crevices around the enclosure. If the animal is accustomed to receiving its food in one bin at a certain time of day, one possible novel presentation would be to put parts of it in different locations at different times.

Care must be taken when providing novel objects or situations within an environmental enrichment plan. The type, quantity, and duration of novelty provided must not be distressing to the primates. Usually, the presentation of novel objects to captive primates is considered to be a benign form of environmental challenge (Fragaszy and Adams-Curtis 1991). However, if the animal is restrained, cannot control its distance from the object, or cannot respond appropriately to the object, the presentation may be detrimental to the animal's well-being.

It is important to know the individual animal and its level of anxiety when introducing novelty or environmental change. Anxiety or fearfulness can vary considerably among individual primates (Box 1991). Individual differences in rhesus monkeys and their responses to stress appear to be highly heritable (Suomi 1987). "High-reactive" rhesus monkeys made up 20% of all rhesus monkey groups screened by Suomi and his colleagues (Suomi *et. al.* 1989). The high-reactive monkeys displayed extreme behavioral and psychological responses to environmental novelty. Restrictive mothering styles that do not encourage independence or allow frequent contact with novel objects and situations can diminish the offspring's ability to deal with novelty and change later in life (Altmann 1980, Fairbanks and McGuire 1988, Simpson 1985). There is no single degree of novelty or collection of novel objects and situations that will be appropriate for all captive primates. The National Research Council recommends each facility evaluate its environmental enrichment plans to accommodate individual animal differences (NRC/ILAR 1998).

The use of novelty as enrichment can best be understood by examining two concepts: complexity and controllability (Sambrook and Buchanan-Smith 1997).

1. Complexity

Environmental complexity for nonhuman primates includes the amount and types of interaction with conspecifics, the number and types of structures, substrates, and manipulable objects present, and the amount and types of sensory stimulation provided. The complexity of an object depends upon its visual, tactile, olfactory, auditory, and gustatory properties. An object's or structure's ability to be used in interactions with conspecifics and its ability to stimulate a wide variety of the senses increases its value as an enrichment device.

Novel objects and situations presented to primates do not have to be complex to generate their interest (Bramblett 1989b). However, evidence suggests primates prefer complex stimuli (Humphrey 1972). Traylor-Holzer and Fritz (1985) concluded that primates need a complex environment. Increased cage complexities have also been shown to be beneficial in reducing fighting and inactivity among primates (Chamove and Anderson 1989, Chamove *et. al.* 1982, McKenzie *et. al.* 1986). Tripp (1985) showed an increase in activity associated with corresponding increases in complexity. Increasing complexity also increased the level of manipulation exhibited by capuchins (Westergaard and Munkenbeck-Fragaszy 1985), lion-tailed

macaques (Westergaard and Lindquist 1987), and squirrel monkeys (Eterovic and Ferchmin 1985, Fragaszy and Mason 1978, Roy *et. al.* 1978).

Providing complexities in a captive primates' environment stimulates a wide array of natural behaviors. Perches and other climbing structures open up vertical cage space to terrestrial and arboreal species for climbing, hanging, and swinging. Complexities must be geared toward the needs of the primate species involved. For macaques, Kopecky and Reinhardt (1991) showed the benefits of using perches rather than swings and placing the perches at the front of the cage to satisfy their inquisitive nature (Reinhardt 1997a).

Just having several structures and complexities available to a group of primates does not guarantee they will continue using them. A study of macaques by Taylor *et. al.* (1997) demonstrated novelty performs a significant role in the continued use of play structures. Over time, use of even preferred structures declines. The authors suggest frequent rotation of play structures will provide the animals with opportunities for exploration and maintain their interest. Most novel items, regardless of their complexity, will ultimately become less interesting. Complex environments and objects are novel only as long as some degree of unpredictability is still present. Fragaszy and Adams-Curtis (1991) agree all novel items become familiar over time and explain that there is currently no agreed upon standard for how long an object or condition retains its novelty. The best criterion for determining whether an object or condition is still novel is the animal's interest in it. Facilities must continually evaluate their enrichment programs and rotate objects and conditions or provide new ones as interest in the current ones decreases.

2. Controllability

Controllability is an interactive component of an enriched environment. Sambrook and Buchanan-Smith (1997) consider control to be highly attractive for animals because it is an adaptive aspect of behavior. All primates seek some form of control in their environment. Adjusting to change, altering confronting stimuli, and organizing response strategies, engage their cognitive capacities (Rosenblum 1991).

Caging reduces the degree of control animals have over their environment and outside stimuli (Chamove and Anderson 1989). The ability to exercise some control over stimuli within the caged environment has been shown to reduce stress in captive animals. Rhesus monkeys that had control over noise levels within their environment had lower plasma cortisol levels than monkeys that did not have control (Hanson *et. al.* 1976). Snowdon and Savage (1989) believe animals must feel some sense of control within their environment and be able to generate a positive response from their actions. From the animal's perspective, the exercise of control over changes in the environment is more important than the degree of novelty in the change (Fragaszy and Adams-Curtis 1991). Young rhesus monkeys, given the opportunity to control food and water by manipulating devices, showed less self-directed behavior and more exploration than monkeys who had no control (Mineka *et. al.* 1986). The same study also showed once an animal has been given control, the consequences of removing it may be worse than if the animal had never been given it.

Primates prefer enrichment devices that give them the opportunity to interact with and generate predictable responses from an object. Being comfortable in a captive environment depends on the primate's ability to produce predictable environmental changes through its own actions (Fragaszy and Adams-Curtis 1991). Guenon monkeys prefer responsive objects such as a rattle or maraca that makes a sound when shaken to unresponsive ones like a rattle or maraca with its contents emptied (Sambrook and Buchanan-Smith 1996). Enrichment devices that allow individuals the opportunity to control their environment will be utilized by a larger number of animals and for longer periods of time than nonresponsive objects (Markowitz and Line 1989).

3. Incorporating Novelty and Control into Enhancement Plans

Novelty and control can be incorporated into environment enhancement plans in a variety of ways, including through social interaction, structures and substrates, foraging, feeding and food items, and manipulanda. Each of these topics is discussed below from the point of novelty and control. For more information, the reader should consult the previous sections on these topics.

According to Novak and Suomi (1991) social interaction is widely considered to be the optimal form of enrichment for primates that are naturally social. French and Inglett (1991) state: "The potential for novelty inherent in social interactions is extensive when one considers the myriad of ways in which social partners interact." The housing of two or more familiar individuals together in an enclosure creates many opportunities for novel interactions. Addition of a new social partner presents a complex set of stimuli and provides opportunities to exercise control.

Social housing is the optimal method for providing novelty. However, the presence of social housing should not preclude other types of environmental enrichment. Addition of novel items and complex stimuli into social housing supports the development and expression of complex social behaviors and interactions. The presence of a partner sometimes makes enrichment devices interesting for a longer period of time. Novel electronic games, introduced into several zoos, quickly became familiar and lost their novelty without the give-and-take of a partner (Markowitz and Line 1989, Rumbaugh *et. al.* 1989).

When animals are housed together, access to novel items can sometimes be restricted by factors related to the primates' age and social status. Fragaszy and Adams-Curtis (1991) showed adult male capuchins and infants less than one year of age enjoyed unlimited access to objects introduced into their cage. Access by juveniles one to three years of age was usually dependent on the relative rank of the mother. Placement of novel items within wood shavings, straw, or other substrates can increase the utilization of these items by preventing monopolization by dominant animals. In studies of hamadryas baboons, high ranking individuals were less responsive than lower ranking animals to the introduction of novel objects (Bunnell *et. al.* 1980, Chamove 1983, Menzel 1971). High status monkeys are sometimes more preoccupied with maintaining their social status than with exploring novelty. A thorough knowledge of the social groupings and natural history of each primate species involved is necessary for optimum utilization of novel items.

To incorporate novelty and control into the environment of primates, facilities should take into account the special needs of infants. As previously stated, mothering styles have an effect on an infant's ability to deal with novelty and change (Altmann 1980, Fairbanks and McGuire 1988, Simpson 1985). Young monkeys who are restricted in their social development explore and play less (Suomi 1987). Play and other beneficial social experiences have been shown to increase an individual's ability to respond to change or new environments (Bekhoff and Byers 1985, Fagen 1978, Geist 1978). Play opportunities may be limited by the number of peers and siblings in the group (Cheney 1978).

The use of novelty and control in structures and substrates is easily demonstrated. Psychological well-being is promoted by adding naturalistic conditions and complex structures that provide opportunities to gain control over and interact with the environment (Snowdon 1991). In Alberta, Canada, the Calgary Zoo has successfully promoted more alert, active, and diverse behaviors by adding leaf piles to its spider monkey exhibit (Stegenga, 1993). Substrates such as straw bedding allow monkeys to produce change in their environment each time they dig in it (Fragaszy and Adams-Curtis 1991). Capuchin monkeys have been shown to use pieces of straw as tools to probe nutboards and other novel objects. Fragaszy and Adams-Curtis (1991) consider straw to be the most important means for providing benign environmental challenge.

Novel food items are an easy way to enrich any captive primate environment. Certain foods, such as coconuts in the husk or corn in the husk enrich primates' environments by creating novel situations (Taff and Dolhinow 1989). Duke University Primate Center successfully incorporated novel and seasonal plant species from North Carolina into the diet of sifakas (Pereira *et. al.* 1989b). Most captive primate diets are restricted to only a few tastes, textures, consistencies, sizes, and colors. In the wild, chimpanzees have been observed to consume between 113 and 205 different foods at various sites (Badrian and Malenky 1984, Hladik 1977, Kano and Mulavwa 1984, Wrangham, 1977). Orangutans (Kortlandt 1984), gorillas (Goodall 1977), and capuchins (Kinzey 1997) eat a wide variety of foods. While the wide variety of foods utilized in nature may not be practically provided for captive primates, any increase in variety will increase complexity and interest in the diet. Novel foods can often be incorporated into foraging devices, hidden in substrates, or presented in novel ways to increase the time needed to find and process them. The use of puzzle feeders and other complex foraging devices allow certain species of primates to manipulate and express cognitive behavior.

Primates use tools more frequently and in more varied ways than any other taxa (Beck 1980, Essock-Vitale and Seyfarth 1987). Their cognitive abilities must be considered when providing manipulanda. Cognitive capabilities present opportunities for primates to respond to environmental conditions in novel ways that may result in additional environmental changes (Box 1991).

Nonhuman primates show a greater variety and complexity of social relations and interactions than any other group of animals (Dasser 1985, Wrangham 1983). This greater complexity of primate social life emphasizes the role of cognition in primates (Box 1991). In singly housed conditions, cognitive stimulation with a variety of manipulanda appears to be more important due to the lack of social complexity and stimulation.

While a certain degree of predictability must be present to provide a comfortable captive environment, total predictability can be boring. Fragaszy and Adams-Curtis (1991) state novelty is present in a system until the individual is certain that all properties within its range of interest are discovered and can be controlled. The challenge of any enrichment program is twofold: (1) to provide novelty that is appropriately stimulating yet non-distressing, and (2) to afford an opportunity for the animal to exert some control over its environment.

Providing social housing, structural complexities, foraging opportunities, and manipulanda that stimulate the senses and incorporate a degree of novelty and control should promote the primates' psychological well-being. However, one should bear in mind that primates have individual personalities and respond differently to novel stimuli. "As with humans, perhaps one monkey's caviar is another's rotten fish." (Novak and Drewsen 1989).

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APPENDIX A. 9 CFR SECTION 3.81

Environment Enhancement to Promote Psychological Well-Being of Nonhuman Primates

CHAPTER I--ANIMAL AND PLANT HEALTH INSPECTION SERVICE, DEPARTMENT OF AGRICULTURE

PART 3--STANDARDS--Table of Contents

Subpart D--Specifications for the Humane Handling, Care, Treatment, and Transportation of Nonhuman Primates

Sec. 3.81 Environment enhancement to promote psychological well-being.

Dealers, exhibitors, and research facilities must develop, document, and follow an appropriate plan for environment enhancement adequate to promote the psychological well-being of nonhuman primates. The plan must be in accordance with the currently accepted professional standards as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. This plan must be made available to APHIS upon request, and, in the case of research facilities, to officials of any pertinent funding agency. The plan, at a minimum, must address each of the following:

(a) Social grouping. The environment enhancement plan must include specific provisions to address the social needs of nonhuman primates of species known to exist in social groups in nature. Such specific provisions must be in accordance with currently accepted professional standards, as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. The plan may provide for the following exceptions:

(1) If a nonhuman primate exhibits vicious or overly aggressive behavior, or is debilitated as a result of age or other conditions (e.g., arthritis), it should be housed separately;

(2) Nonhuman primates that have or are suspected of having a contagious disease must be isolated from healthy animals in the colony as directed by the attending veterinarian. When an entire group or room of nonhuman primates is known to have or believed to be exposed to an infectious agent, the group may be kept intact during the process of diagnosis, treatment, and control.

(3) Nonhuman primates may not be housed with other species of primates or animals unless they are compatible, do not prevent access to food, water, or shelter by individual animals. and are not known to be hazardous to the health and well-being of each other. Compatibility of nonhuman primates must be determined in accordance with generally accepted professional practices and actual observations, as directed by the attending veterinarian, to ensure that the nonhuman primates are in fact compatible. Individually housed nonhuman primates must be able to see and hear nonhuman primates of their own or compatible species unless the attending veterinarian determines that it would endanger their health, safety, or well-being.

(b) Environmental enrichment. The physical environment in the primary enclosures must be enriched by providing means of expressing noninjurious species-typical activities. Species differences should be considered when determining the type or methods of enrichment. Examples of environmental enrichments include providing perches, swings, mirrors, and other increased cage complexities; providing objects to manipulate; varied food items; using foraging or task-oriented feeding methods; and providing interaction with the care giver or other familiar and knowledgeable person consistent with personnel safety precautions.

(c) Special considerations. Certain nonhuman primates must be provided special attention regarding enhancement of their environment, based on the needs of the individual species and in accordance with the instructions of the attending veterinarian. Nonhuman primates requiring special attention are the following:

(1) Infants and young juveniles;

(2) Those that show signs of being in psychological distress through behavior or appearance;

(3) Those used in research for which the Committee-approved protocol requires restricted activity;

(4) Individually housed nonhuman primates that are unable to see and hear nonhuman primates of their own or compatible species; and

(5) Great apes weighing over 110 lbs. (50 kg). Dealers, exhibitors, and research facilities must include in the environment enhancement plan special provisions for great apes weighing over 110 lbs. (50 kg), including additional opportunities to express species-typical behavior.

(d) Restraint devices. Nonhuman primates must not be maintained in restraint devices unless required for health reasons as determined by the attending veterinarian or by a research proposal approved by the Committee at research facilities. Maintenance under such restraint must be for the shortest period possible. In instances where long-term (more than 12 hours) restraint is required, the nonhuman primate must be provided the opportunity daily for unrestrained activity for at least one continuous hour during the period of restraint, unless continuous restraint is required by the research proposal approved by the Committee at research facilities.

(e) Exemptions. (1) The attending veterinarian may exempt an individual nonhuman primate from participation in the environment enhancement plan because of its health or condition, or in consideration of its well-being. The basis of the exemption must be recorded by the attending veterinarian for each exempted nonhuman primate. Unless the basis for the exemption is a permanent condition, the exemption must be reviewed at least every 30 days by the attending veterinarian.

(2) For a research facility, the Committee may exempt an individual nonhuman primate from participation in some or all of the otherwise required environment enhancement plans for scientific reasons set forth in the research proposal. The basis of the exemption shall be documented in the approved proposal and must be reviewed at appropriate intervals as determined by the Committee, but not less than annually.

(3) Records of any exemptions must be maintained by the dealer, exhibitor, or research facility and must be made available to USDA officials or officials of any pertinent funding Federal agency upon request.

(Approved by the Office of Management and Budget under control number 0579-0093)

APPENDIX B. GLOSSARY*

* See Rowe (1996) for definitions and descriptions of terms relating to types of primates such as: bonobos, callitrichids, cynomologous, guenons, hamadryas, mangabeys, patas, prosimians, tarsiers.

9 CFR--the ninth volume of the Code of Federal Regulations which contains the regulations implementing the Animal Welfare Act. The part of them that deals with environment enhancement to promote psychological well-being of nonhuman primates is 9CFR3.81.

affiliative--close, friendly social relations

agonism--aggressive or defensive social interaction (such as fighting or fleeing) between individuals

arboreal--inhabiting or frequenting trees

allomothering--care of an infant by a group member other than its mother (similar to babysitting)

alloparenting--care of an infant by a group member other than its parent (similar to babysitting)

antihepatotoxic--counteracting substances that damage the liver or preventing damage to it

APHIS--the Animal and Plant Health Inspection Service, part of the U.S. Department of Agriculture

astroturf--pads of short, artificial grass

AWA--Animal Welfare Act (7 U.S.C. 2131 et. seq.) Section 13. (a) (2) (B) pertains to the promulgation of standards to govern the humane handling, care, treatment and transportation of animals by dealers, research facilities, and exhibitors. The standards shall include minimum requirements for exercise of dogs.. and "for a physical environment adequate to promote the psychological well-being of primates."

AWIC--the Animal Welfare Information Center, part of the U.S. Department of Agriculture

Berlin Workshop--*the International Workshop on the Accommodation of Laboratory Animals in Accordance with Animal Welfare Requirements, Berlin 17-19 May 1993*

brachiate--to progress by swinging while suspended from one hold to another by the hands

CCAC--Canadian Council on Animal Care

conspecific--individuals of the same species

Email--electronic messaging through computer networks

gustatory--pertaining to the sense of taste

intraspecific--occurring within a species or involving members of one species

isosexual--a pair or group of animals all of the same sex

manipulanda--things to move, treat, or operate with the hands

minimalistic--using the fewest and simplest elements

monogamous--having only one mate at a time

NHP--nonhuman primate

NIH--the National Institutes of Health, part of the U. S. Department of Health and Human Services

neophobia--fear of anything new

nocturnal--active at night

nonresponsive--not giving an action in return when touched or moved

NRC/ILAR--the National Research Council, Institute for Laboratory Animal Research

olfactory--pertaining to the sense of smell

phylogenetically remote--species that are genetically very distant and unlike

polyandrous--having more than one male mate at a time

polygamous--having more than one mate at a time

preformulated--mixed together according to a formula in a factory before sale

primatological--pertaining to the study of primates (apes, monkeys and related forms)

PWB--psychological well-being

reingestion--taking in for digestion a second time

resocialize--to readjust to a social group or partner after an absense

sociality--social nature

stereotypy--frequent, mechanical repetition of the same posture or movement

sternally--on the chest or front side

surrogate--a substitute

thermoconductive--transmitting heat or cold through it

webpage--a page of information displayed on the World Wide Web computer network

xenophobia--fear of strangers or foreigners or of anything that is strange or foreign

APPENDIX C. SAMPLE SPECIES INFORMATION SHEETS

In order to help APHIS inspectors and facilities understand better how to enhance the psychological well-being of nonhuman primates they inspect or own, APHIS is attemping to develop some resource materials for distribution. Sheets like the following will be drafted for the primates species found most commonly in the U.S. At this point in time, they are only illustrative of the final product, and will be changed when we have experience drafting several more. They give some useful facts about the primate species, how they live in the wild, suggest options or strategies for meeting the critical elements, and list sources for further research. The details are recommendations, not absolute requirements. We hope they provide an idea of the acceptable range of variation for facilities' plans.

The page numbers of this appendix are not in sequence--only the sample pages are included.

APPENDIX C: SPECIES INFORMATION SHEETS-TABLE OF CONTENTS-2/8/99

Name: *Ateles geoffroyi panamensis* (Central American spider monkey)

Morphology: The spider monkey's tail is well adapted for seizing or grasping and is called prehensile. The sole or bottom skin surface is hairless and has grooves like fingerprints that enhance its ability to grasp branches. Spider monkeys use their tails as fifth limbs and can support the whole weight of their bodies with them. They have flexible shoulder joints for swinging from one branch to another (brachiating). Their arms are elongated and their hands are adapted into suspensory hooks. Thumbs are absent or very small, and the fingers are long and permanently curved. *A. geoffroyi* lives in Central America and is also known as the black-handed spider monkey and is distinguished by having hair that is light in color (buff or reddish). Its neighbors in South America (*A. fusciceps*, *A. paniscus*, and *A. chamek*) tend to be black.

Postures: Spider monkeys sit, lie in all positions, and stand erect with arms stretched vertically. They feed while suspended from their tails in tree branches and use their tails as anchors. Their suspensory postures are probably an adaptation that allows them to reach food at the end of thin branches.

Locomotion and positions: Spider monkeys walk well on two legs, bipedally. They also walk, run, and leap on four legs, quadrupedally, with their bodies held horizontally. They brachiate frequently and superbly, almost as well as gibbons. In bridging from one tree to another, the spider monkey commonly grasps the base tripedally with hind feet and tail and reaches for the target with its hands. Spider monkeys tend to keep their heads upward and descend feet first. They frequently make long jumps outward and downward, covering great distances.

Habitat: Spider monkeys have been found throughout Central America from Veracruz, Mexico to Panama. They inhabit old, tall, spacious forests of evergreens, semideciduous trees, and mangrove trees. They adapt readily to changes in climate and do not sleep in holes in trees. While early accounts suggest that they were contemptuous of potential predators at one time, in modern times they are being hunted for food and have become shy of man. They are listed as vulnerable by the World Conservation Union and their survival is threatened by the increasing destruction of the forest by humans.

Feeding, food, diet: The *geoffroyi's* diet consists of more than three quarters fruit--high quality, energy-rich fruit, which is hard to find and widely scattered. They travel long distances in big home ranges to maximize their fruit intake. Small fruits are swallowed whole without chewing and the seeds dispersed. The remainder of their diet consists of decreasing percentages of seeds, flowers, young leaves, buds, mature leaves, and animal prey. (The animal prey could be insects, larva, bird eggs, and baby birds.)

Sensory uses, adaptations: *Tactile*: Lacking thumbs, spider monkeys are not good manipulators. However, the naked skin on their tails contains sweat glands and sensory nerve endings similar to those on hands. Females pick through the hair of their young, making long downward currying movements, parting the hair and searching over the skin, but do not frequently explore the hair and remove particles as do macaques and capuchins. *Olfactory:* Spider monkeys have glands near the base of the neck that appear to give off olfactory signals. Their stereotyped embrace and pectoral sniffing behavior are probably olfactory examinations of these glands. Rubbing their chests with their hands or arms and then against objects may transmit the secretions for scent marking purposes. Males like the smell of the urine of females. *Auditory*: Their auditory sense is well developed and used for vocal communication.

Communication: Spider monkeys communicate vocally to keep in touch with each other while eating and traveling. Their repertoire of sounds includes: a terrier-like bark signalling the approach of strangers; growls given by adults when closely approached by strangers or when contending subgroups are aroused; and high-pitched whinnies given when subgroups or

individuals become separated and need to be coordinated with the others. Captive infant spider monkeys do not utter play vocalizations. Postures and bodily attitudes are means of communication that are taught to infants by their mothers. Some facial expressions have become associated with certain states of motivation and call forth responses. The protruding lips, squinted eyes and wrinkled forehead seem to indicate an attitude of approach and friendliness. The half-open mouth emitting a series of grunts seems to indicate sexual receptivity. In aggressive situations such as response to human intruders, spider monkeys put on vigorous branch shaking displays, accompanied by scratching and staring.

Social Structure, social behavior, reproduction: Black-handed spider monkeys congregate in large troops, up to 35, when resources permit. These may consist of one or more females with one or more young, one or more males with many females, or a group comprised of all males. Groups having a large number of individuals in the early morning may disband by midmorning and regroup with different individuals in the afternoon.

Groups of spider monkeys seem to have no highly centralized social control. Social control is diffuse. The few instances of fighting that he observed consisted of males contending with each other. Male aggressive behavior is infrequent and directed towards other males when it occurs, and adult males are ranked in a dominance order. Male spider monkeys spend less time feeding at each site and travel farther than females. Males have the largest territories. There are also dominance relations among some females. Spider monkeys occasionally associate with white-throated capuchins (*Cebus capucinus.)*

A great variety of play patterns is shown by young spider monkeys, but little play occurs among adults. Play consists of running, jumping from one branch to another, standing still and jumping up and down, swinging from a limb, and playing with sticks or other objects. Young spider monkeys may chase each other for hours over circuitous routes, or may catch and bite each other. Wrestling occurs when they are sitting on limbs or swinging by their tails.

Development, parental care: *Infancy*: 0 - 24 months. During the first six months of their lives, young spider monkeys are almost entirely dependent on their mothers. This dependency continues until they are well into their reddish color phase, about ten months of age. Infancy is from 0 to 24 months (Milton 1973), the longest known period of dependency of any cebid. Infants ride on their mothers' backs. The mother may control the movements and postures of her infant by forceful directing. Thereby the behavior of the two animals becomes coordinated. After repetition, the young come to respond to reduced cues and postures and bodily attitudes become means of communication. *Sexual maturity*: 48 - 60 months. The estrus cycle is 26 days. *Gestation*: 226 - 232 days. *Birth intervals*: 17 - 45 months. *Life span*: 27 years.

Other special behaviors, adaptations: Spider monkeys spend over half their time resting, a quarter traveling, and about 10 percent feeding. There is no sexual dimorphism in body size. The clitoris of the female is long and pendulous and females can be misidentified as males.

Enrichment Strategies Recommended:

1. Social Grouping: It is recommended that spider monkeys be housed in groups composed of a single male with multiple females. A troop with several adult males and females and a variety of young of different ages is desirable if the members are compatible.

2. Social Needs of Infants: Infant spider monkeys should stay with their mothers at least 6 months. If possible they should be allowed to stay until they stop nursing, which may be much longer.

3. Structure and Substrate:

Cage structure must allow for species-typical resting and brachiation. Ropes, swings, multiple level perches and branches for climbing, jumping, and swinging.

Adequate vertical space and postural supports to enable all animals to move and perch with their tail hanging in a normal position of rest without touching the floor.

Space for jumping, laterally and vertically, and brachiation.

It is also important to have boxes or hiding areas which offer visual barriers.

4. Foraging Opportunities:

Task oriented feeding such as: offering food on the outside of the enclosure and requiring the animals to get it through the bars or wire; hanging food and requiring them to eat while suspended; and hiding fruit or popcorn in mesh or paper bags filled with straw or shredded paper.

Browse placed in natural positions, upright or hanging down.

If the floor is solid, seeds, fruit, and nuts scattered in litter composed of straw, leaves, wood shavings, or corn cobs.

Puzzle feeders or pipe feeders

5. Manipulanda:

Test various simple objects to see if they can be manipulated with hands, feet, and tails.

Try items that provide stimulation of other senses, such as balls, chew toys, and rattles.

6. Sensory Stimulation:

Mirrors that can be used to view the outdoors, care givers, other primates, or around the room.

Taped sounds of their species, radios, TV

Scent-marking articles (logs, sticks, rags, or plant material)

Sanitation procedures should take into consideration the possible importance of odors for the cage inhabitants. The presence of odors should not be taken to mean that sanitation is inadequate.

Varied food texture, smell, and flavor (hot, sour, or pungent.)

Naturalistic settings (branches, tree limbs, vines, and floor litter).

7. Novelty and Control: Spider monkeys cannot explore or control some features of their surroundings as intensively or efficiently as monkeys which have hands that can do more things. However, they have large and complex brains, appear to be very intelligent, and are the most adaptable of *ceboids* in locomotory patterns and some of their social reactions. Given this, it seems that periodic changes in ropes, swings, perches, and branches would be especially appropriate.

Note: The National Research Council (1998:66-74) gives information on proper housing temperatures, nutrition, personnel procedures, veterinary care, and other topics.

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GLOSSARY

Arboreal: Adapted to life in the trees

Bipedal: Using only two limbs for locomotion, as in humans or birds.

Brachiating: Swinging by the hands from one branch to another.

Dimorphism: (Sexual) Size, color, or weight variation between genders of the same species

Manipulanda: Items/objects that can be handled/manipulated

Olfactory: Related to the sense of smell

Quadrupedal: Using four limbs for locomotion

Sole: (of the tail) The bottom (ventral) skin surface

Name: *Cebus apella* (tufted, black capped or brown capuchin monkey)

Morphology: Medium sized monkey with head and body length equal to the tail length. Bodies are robust and heads are rounded. Limbs are rather short, especially the arms. Tail is semi-prehensile and is lacking a prehensile sole. Has a thick mat of erect brown hairs on the crown, sometimes forming tufts at the side of the head. The brain is extremely large in relation to body weight.

Postures and locomotion: Basically quadrupedal (86%) with leaping (7%) and climbing (6.5%). Jumps up to 10-12 feet. The tail adds postural support. Rests in a sitting position or curled up on its side or stretched out on a branch with arms and legs dangling, but always with tail tip anchored to a branch.

Habitat: *C. apella* is the most widespread of the capuchin species. Has the largest range of any New World monkey. Found throughout South America east of the Andes in subtropical and tropical forest, except Uruguay and Chile. Prefers moister forests than other capuchins and ranges to higher elevations. Normally occupies under story trees 5 to 20 meters high with crowns less than 10 meters in diameter.

Feeding, food, diet: Capuchins are frugivore-insectivores whose diet includes both fruits and invertebrates. *C. apella* is particularly fond of cumare and palmnut. It uses special nut cracking techniques to reach the kernel. It is also adept at catching and eating tree frogs which it extracts from bamboo trunk cavities. It is very adaptable and may exploit over 90 plant species a year. It eats more vegetation and larger fruits than other species. Bark stripping and breaking open branches to hunt for insects. Overall body size and strong jaws allow proficient manipulation of tough foods.

Sensory uses: *Olfactory:* Scent marker with each individual maintaining olfactory identity by washing palms and feet with its urine (urine washing). Rub plants and other items in their environment into their fur. *Tactile:* Tactile sense is well developed with excellent manipulative ability. Highly intelligent species of neotropic primates. Typically pick up, handle, visually inspect, bite, pull, hit and rub any nonthreatening objects encountered.

Communication: Vocalizations including a variety of chatters, squeaks, shrieks, and other sounds for communication, facial expressions, lip smacking and urine washing. Chemical signals might identify an individual animal's sex and play important roles in reproductive behavior, agressive interactions, and other kinds of behaviors.

Social structure, behavior, reproduction: Diurnal and arboreal. Socialize in multimale-multifemale groups, usually with an equal number of males and females. Group size is usually 3-15 with one dominant male and one dominant female. Groups composed of 1-4 adult and subadult males, 1-4 adult and subadult females, and their juvenile offspring. Dominant males serve as watchdogs and protectors of social groups. Adult males form affiliations and there is a high degree of tolerance among males within social groups. Play fighting is the primary form of social contact among males, among juveniles, and between males and juveniles Adult females interact with adult females and juveniles. Social contact between females consists primarily of mutual grooming and sitting in close contact. Male emigration to other troops occurs between 3-5 years of age. Males are sexually mature at 5 years of age and females around 4 years. Adult and subadult females are more likely than males to engage in aggressive behavior. Kin-relations are important in establishing stable groupings.

Infant development and parental care: During the first month of life the infant is carried transversely on the back of its mother, then longitudinally thereafter. Mothers and siblings frequently interact with infants during the first 6 months of life and it is termed the 'kin phase'.

Aside from the mother, siblings are the most important social partners during the 'kin phase'. Allomothering is common. Infants can be carried by adults and juveniles other than the mother. The second 6 months are termed the 'peer phase' for infants because of frequent interaction by the infant with other infants and juveniles one year older. Infants still maintain close contact to kin-related animals during the 'peer phase'. Grooming of infants is primarily done by the mother and older female siblings. Age of weaning is 12 months.

Other special behaviors, adaptions: Adept with their hands and exhibit precision grips that require independent control of digits. Tool using has been reported. Persistent manipulators of objects. Show extreme interest in the manipulative activities of other capuchins. Utilize special nut cracking techniques and are noted for their ingenuity in extracting tree frogs from cavities in bamboo trunks. Urine washing as a marking behavior is thought to be used only in Cebus species.

The National Research Council (1998:72) reports that, "Capuchins.. show greater manipulative ability than rhesus monkeys and are the prototype of the active monkey for which provision of opportunities for productive activity is essential to well-being. When not locomoting, they are most often busy with their hands.. When no other opportunities are present, their attention is directed to surfaces in the cage or nearby objects, such as locks. This activity can be safely redirected by providing them with such objects and materials as wood, soft plastic, straw, and small containers.. They will spend much time shredding and destroying disposable objects. They also retain interet in objects that require dexterous probing or scraping."

Enrichment Strategies Recommended

1. Social Grouping:

It is recommended that capuchins be housed in single male and multiple female groups. When sufficient space is available, provide interior walls or hanging panels to allow segregation and sanctuary and establish multiple male/multiple female groups.

Kin-relations are important to establishing multiple male/multiple female groups.

2. Social Needs of Infants: Infants should not be removed from their mother/sibling unit until at least 1 year of age.

3. Structure and Substrate:

Solid floored cage with bedding material of straw (preferably) or other materials that provide manipulative opportunities.

Tire swings, suspended perches suitable for resting, climbing ropes, natural branch structures which allow tail grasping.

Hanging rubber panels and interior walls for natural group segregation.

Adequate vertical space and postural supports to enable all animals to move and perch with their tail hanging in a normal position of rest without touching the floor.

Space for jumping laterally and vertically.

4. Foraging:

Scatter seeds, diced vegetables, hard shell nuts and other relished treats in the bedding.

Provide puzzle feeders that require persistent manipulation to acquire food items.

Provide complex foraging units with visual and hidden cavities for touch dependent foraging

Nut boards

External food or liquid wells that require tool use (sticks, straw etc.) to acquire foods

Pipe feeders

Mechanical or electrical food dispensers

Suspended or cage top feeding

5. Manipulanda:

Novel objects of wood or soft plastic; containers

Portable objects (such as sticks or straw) that can be used as probes or tools

Indestructible toys, especially those with moving parts

Problem box tasks that stimulate cognitive behaviors

Branches with attached bark or disposible objects to shred or destroy.

6. Sensory Stimulation:

Naturalistic settings/substrates

Group housing

Wide variety of fruits, nuts, vegetables, and invertebrates that provide olfactory, gustatory and textural stimulation.

Wide variety of toys with different textures and both visual and manipulative complexities.

Sanitation procedures should take into consideration the possible importance of odors for the cage inhabitants. The presence of odors should not be taken to mean that sanitation is inadequate.

7. Novelty and Control:

Rotate different types of bedding substrate

Provide novel and seasonal food items/treats/foliage

Vary treats/food items within foraging tasks

Vary types of toys and manipulanda

Periodically rotate in and rearrange perches and climbing structures

Note: The National Research Council (1998:66-74) gives information on proper housing temperatures, nutrition, personnel procedures, veterinary care, and other topics.

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GLOSSARY

Allomothering: Care of an infant by a group member other than its mother; (similar to babysitting)

Arboreal: Adapted to life in the trees

Diurnal: Active during the day

Frugivore: An animal that eats fruit as a major percentage of its diet

Gustatory: Of tasting, or the sense of taste

Insectivore: An animal that eats insects as a major percentage of its diet

Manipulanda: Items/objects that can be handled/manipulated

Neotropic: The tropical regions of Central and South America

Olfactory: Of smelling, or the sense of smell

Prehensile: Able to grasp while wrapping around. Often refers to tails of some larger Neotropic monkeys

Quadrupedal: Using four limbs for locomotion

Sole (of the tail): The bottom (ventral) skin surface

Notes

1. A standard is called "performance-based" because it relies on qualities of the result or end-product of facility activity and allows facilities to decide how best to achieve results. They must document their decisions in "performance plans." When a standard is performance-based, facilities are responsible for the results and are encouraged to constantly examine and improve their methods. This kind of a standard contrasts with so-called "engineering" or "design" standards which specify exact methods. Design standards are presumed to allow less latitude for the facility than performance-based standards. Performance-based standards may be difficult to use and enforce if their end-points are not well-defined. The Institute for Laboratory Animal Resources' (ILAR's) *Guide for the Care and Use of Laboratory Animals* states, "Optimally, engineering and performance standards are balanced, thereby providing standards while allowing flexibility and judgement based on individual situations" (NRC/ILAR 1996:3).

2. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Care (1996). USDA Employee Opinions on the Effectiveness of Performance-Based Standards for Animal Care Facilities. USDA, APHIS: Riverdale, Maryland, December, 1996. The study also evaluated 9 CFR, Part 3, Subpart A, 3.8, Exercise for Dogs.

3. However, at research facilities animals may be housed or used in exception to any standard if the alternative treatment is scientifically justified and documented in an experimental protocol approved by an Institutional Animal Care and Use Committee.

4. Kessel and Brent 1995a and 1995b (baboons), Salzen 1989 (squirrel monkeys), Seier and de Lange 1996 (vervets), Tustin *et. al.* 1996 (Japanese macaques), Brent *et. al.* 1991 (chimps), Eichberg *et. al.* 1991 (chimps), Bennett and Davis 1989 (rhesus monkeys), Blackmore 1989 (macaques), Gilbert and Wrenshall 1989 (long-tailed macaques), King and Norwood 1989 (squirrel monkeys), Lynch and Baker 1998 (long-tailed macaques), Taylor and Laudenslager 1998 (pig-tailed macaques), Wolff and Ruppert 1991 (rhesus and cynomologous macaques and capuchins), Chance *et. al.* 1983 (cynomologous macaques).

5. Weed *et. al.* 1995 (baboons), Doyle *et. al.* 1996 (baboons), Kaplan and Lobao 1991 (rhesus), Adams and Britz 1997 (baboons), Burt and Plant 1990 (stump-tailed macaques), Applebee *et. al.* 1991 (rhesus)

6. Brent *et. al.* 1991, Kessel and Brent 1995a and 1995b, Taylor and Laudenslager 1998, Schoenfeld 1989, Perkins 1992, Seier and deLange 1996, Marriott *et. al.* 1993, Tustin *et. al.* 1996, Kerl and Rothe 1996, Clarke *et. al.* 1982, Wolff and Ruppert 1991, Blackmore 1989, Bryant *et. al.* 1988, Tolan *et. al.* 1980, Fouts *et. al.* 1989, Leu *et. al.* 1993.

USDA Draft Policy on Environmental Enhancement for Nonhuman Primates

two copies of their views to USDA/AMS/Dairy Programs, Order Formulation Branch, Room 2971, South Building, P.O. Box 96456, Washington, DC 20090–6456, by the 7th day after publication of this notice in the Federal Register. The period for filing comments is limited to 7 days because a longer period would not provide the time needed to complete the required procedures before the start of the next marketing period.

All written submissions made pursuant to this notice will be made available for public inspection in Dairy Programs during regular business hours (7 CFR 1.27(b)).

Statement of Consideration

The proposed rule would suspend certain provisions of the Central Arizona order until completion of Federal Order Reform. The proposed suspension would remove the requirement that a cooperative association which operates a manufacturing plant in the marketing area must ship at least 50 percent of its milk supply during the current month or the previous 12-month period ending with the current month to other handlers' pool plants to maintain the pool status of its manufacturing plant.

The order permits a cooperative association's manufacturing plant, located in the marketing area, to be a pool plant if at least 50 percent of the producer milk of members of the cooperative association is physically received at pool plants of other handlers during the current month or the previous 12-month period ending with the current month.

Reinstatement of the suspension which expired on March 31, 1999, was requested by United Dairymen of Arizona (UDA), a cooperative association which represents nearly all of the dairy farmers who supply the Central Arizona market. UDA contends that the pool status of their manufacturing plant would be threatened if the suspension is not reinstated. UDA states that the same marketing conditions that warranted the suspension for the past four years still exist. UDA maintains that members who increased their milk production to meet the projected demands of fluid handlers for distribution into Mexico continue to suffer the adverse impact of the collapse of the Mexican peso. Absent a suspension, UDA projects that costly and inefficient movements of milk would have to be made to maintain the pool status of producers who have historically supplied the market and to prevent disorderly marketing in the Central Arizona marketing area.

Accordingly, it may be appropriate to suspend the aforesaid provisions at the beginning of the next marketing period until completion of Federal Order Reform.

List of Subjects in 7 CFR Part 1131

Milk marketing orders.

The authority citation for 7 CFR Part 1131 continues to read as follows:

Authority: 7 U.S.C. 601–674.

Dated: July 9, 1999.

Richard M. McKee,

Deputy Administrator, Dairy Programs.

[FR Doc. 99–18051 Filed 7–14–99; 8:45 am]

BILLING CODE 3410–02–P

DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service

9 CFR Part 3

[Docket No. 98–121–1]

Animal Welfare; Draft Policy on Environment Enhancement for Nonhuman Primates

AGENCY: Animal and Plant Health Inspection Service, USDA.

ACTION: Draft policy statement and request for comments.

SUMMARY: Under the Animal Welfare Act, our regulations require that dealers, exhibitors, and research facilities that maintain nonhuman primates develop and follow a plan for environment enhancement adequate to promote the psychological well-being of the nonhuman primates. We have developed a draft policy to clarify what we believe must be considered and included in the plan in order for dealers, exhibitors, and research facilities to adequately promote the psychological well-being of nonhuman primates. We are seeking public comment on the draft policy before we implement it.

DATES: We invite you to comment. We will consider all comments that we receive by September 13, 1999.

ADDRESSES: Please send an original and three copies of your comments to Docket No. 98–121–1, Regulatory Analysis and Development, PPD, APHIS, suite 3C03, 4700 River Road Unit 118, Riverdale, MD 20737–1238. Please state that your comments refer to Docket No. 98–121–1. Comments received may be inspected at USDA, room 1141, South Building, 14th Street and Independence Avenue SW., Washington, DC, between 8 a.m. and 4:30 p.m., Monday through Friday, except holidays. Persons wishing to inspect comments are requested to call ahead on (202) 690–2817 to facilitate entry into the comment reading room.

FOR FURTHER INFORMATION CONTACT: Natalie Roberts, Ph.D., Program Evaluation and Monitoring, PPD, APHIS, 4700 River Road Unit 120, Riverdale, MD 20737–1234, (301) 734–8937; or e-mail: Natalie.A.Roberts@usda.gov.

SUPPLEMENTARY INFORMATION: The Animal Welfare Act (AWA) (7 U.S.C. 2131 *et seq.*) authorizes the Secretary of Agriculture to promulgate standards and other requirements governing the humane handling, housing, care, treatment, and transportation of certain animals by dealers, exhibitors, and other regulated entities. The Secretary of Agriculture has delegated the responsibility for enforcing the AWA to the Administrator of the Animal and Plant Health Inspection Service (APHIS). Regulations established under the AWA are contained in 9 CFR parts 1, 2, and 3. The APHIS Animal Care program ensures compliance with the AWA regulations by conducting inspections of premises with regulated animals.

Subpart D of 9 CFR part 3 contains requirements for the humane handling, care, treatment, and transportation of nonhuman primates. Under subpart D, § 3.81 requires that dealers, exhibitors, and research facilities that maintain nonhuman primates develop, document, and follow an appropriate plan for environment enhancement adequate to promote the psychological well-being of nonhuman primates. Section 3.81 further requires that the plan be in accordance with currently accepted professional standards, as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. At a minimum, § 3.81 requires the plan to address:

- The social needs of nonhuman primates known to exist in social groups;
- Enrichment of the physical environment of the nonhuman primates by providing means of expressing noninjurious species-typical behavior;
- Special considerations for infant and young nonhuman primates; nonhuman primates that show signs of psychological distress, are restricted in their activities, or are individually housed; and great apes weighing over 110 lbs.

Further guidance and specific examples are provided in § 3.81 for determining when social grouping of nonhuman primates is inappropriate and ways to provide environmental enrichment. In

addition, § 3.81 places restrictions on the use of restraint devices and prescribes when and how individual nonhuman primates may be exempted from participation in the plan.

History of APHIS Regulations on Psychological Well-Being of Nonhuman Primates

The regulations in § 3.81 were established as part of a final rule published in the Federal Register on February 15, 1991 (56 FR 6426–6505, Docket No. 90–218). The final rule stipulated that plans for promoting the psychological well-being of nonhuman primates must be implemented by August 14, 1991. The establishment of these regulations was in response to amendments to the Animal Welfare Act made by Congress in 1985. Among other things, the 1985 amendments directed the Secretary of Agriculture to promulgate new regulations for a physical environment adequate to promote the psychological well-being of nonhuman primates.

Nonhuman primates include more than 240 species, ranging from the tiny marmoset to great apes. They live in different habitats in nature, and their nutritional, activity, social, and environmental requirements vary. As a result, the conditions appropriate for one species do not necessarily apply to another. In addition, the 1985 amendments to the Animal Welfare Act, while mandating that we establish regulations for a physical environment adequate to promote the psychological well-being of nonhuman primates, did not give us the authority to interfere with actual research.

With these things in mind, we intentionally made the regulations regarding promotion of psychological well-being flexible. The regulations we established in § 3.81 are performance standards, meaning they state a goal that must be met (an environment adequate to promote the psychological well-being of nonhuman primates) and provide minimum requirements on how to meet the goal. Within the minimum requirements, dealers, exhibitors, and research facilities have the flexibility to develop a plan that will address the specific needs of the nonhuman primates they maintain and, for research facilities, that will address the scientific needs of research.

Further, what constitutes psychological well-being in each species and each primate does not lend itself to precise definition. After consultation with primate experts and using the accepted professional standards available at the time, we based the regulations on the concept that, to promote the psychological well-being of nonhuman primates, a balance of several factors or areas of concern must be addressed. As noted above, this concept, as set forth in § 3.81, involves providing methods of social interaction with other nonhuman primates or humans; providing methods to physically and mentally stimulate the nonhuman primates and occupy some of their time; and considering the special needs of certain nonhuman primates, such as infants and young juveniles or great apes. Stipulating areas of concern that must be addressed, as opposed to more rigid design standards, allows dealers, exhibitors, and research facilities flexibility to tailor the plan so that it is appropriate to the species or individual being maintained.

The performance standards in § 3.81 require first and foremost that the plan for environment enhancement be in accordance with currently accepted professional standards, as cited in appropriate professional journals or reference guides, and as directed by the attending veterinarian. This allows flexibility for dealers, exhibitors, and research facilities in developing their guides as advances are made in the understanding of ways to assess and promote psychological well-being in nonhuman primates.

Draft Policy on Psychological Well-Being of Nonhuman Primates

In 1996, after 5 years of experience enforcing § 3.81, we evaluated the effectiveness of the performance standards by surveying our inspectors about their experience in reviewing environment enhancement plans developed under § 3.81. The results of our evaluation indicated that dealers, exhibitors, and research facilities did not necessarily understand how to develop an environment enhancement plan that would adequately promote the psychological well-being of nonhuman primates. In addition, there has been considerable disagreement in various sectors of the public over the adequacy of the performance standards in § 3.81, as well as confusion among the regulated public concerning on what basis they will be judged by inspectors as meeting or not meeting the requirements. Our inspectors requested information and clarification on how to judge whether someone was meeting the requirements in § 3.81.

While we continue to believe that the flexibility of the performance standards in § 3.81 is in the best interests of the animals covered by the regulations, we do believe that additional information on how to meet the standards in § 3.81 is necessary. We have, therefore, developed a draft policy on environment enhancement for nonhuman primates. The draft policy appears at the end of this document. We intend this policy to be used by dealers, exhibitors, and research facilities as a basis in developing plans under § 3.81 for environment enhancement to promote the psychological well-being of nonhuman primates.

We based the draft policy on an extensive review of the available primate literature, professional journals, and reference guides. We also consulted veterinarians, primatologists, and our inspectors. The draft policy represents what we believe are the currently accepted professional standards for promoting the psychological well-being of nonhuman primates through enhancement of the primates' environment. We believe this draft policy will assist regulated entities by clarifying what actions we consider necessary in order to comply with the requirements of § 3.81.

We state in the draft policy that dealers, exhibitors, and research facilities who house nonhuman primates will meet the requirements of § 3.81 if they develop and follow environment enhancement plans that are in accordance with the draft policy. However, we recognize that there may be other options that would also meet the requirements of § 3.81. Our adoption of this draft policy would not prevent regulated entities from developing practices other than those in the draft policy, as long as those practices meet the requirements of § 3.81. Likewise, our adoption of this draft policy would not prevent regulated entities from using alternative sources or research materials in developing their environment enhancement plans, as long as the resulting plans meet the requirements of § 3.81. If a dealer, exhibitor, or research facility wants assurance that an alternative plan (not in accordance with the draft policy) is in compliance with § 3.81, they may request approval of the plan in writing from the Deputy Administrator of Animal Care.

The draft policy identifies five general elements that we believe are critical to environments that adequately promote the psychological well-being of nonhuman primates: Social grouping, social needs of infants, structure and substrate, foraging opportunities, and manipulanda. These five elements are represented in the minimum requirements in § 3.81 concerning social grouping and environmental enrichment. The five elements, and detailed information provided for each, describe what we believe to be the currently accepted professional

standards to meet the minimum requirements in § 3.81. We also state in the draft policy that facilities are encouraged to explore additional elements and innovations and to exceed the requirements of the draft policy and the regulations.

In addition, we have prepared a report that describes the scientific basis for the draft policy and the methods we used in developing the draft policy, including a literature review and discussion and a list of references. You can obtain a copy of this report by contacting the person listed under **FOR FURTHER INFORMATION CONTACT** at the beginning of this document. The report can also be viewed at any Animal Care Regional Office and in our comment reading room. The address for our comment reading room appears in the **ADDRESSES** section at the beginning of this document. Finally, the report is posted on the Animal Care home page at http://www.aphis.usda.gov/ac/info.html.

We are seeking public comment on the content of the draft policy before we implement it. The draft policy is as follows:

Draft Policy on Environment Enhancement for the Psychological Well-Being of Nonhuman Primates

The regulations in 9 CFR 3.81 require that dealers, exhibitors, and research facilities develop, document and follow an appropriate plan for environment enhancement adequate to promote the psychological well-being of nonhuman primates, and that the plan be in accordance with currently accepted professional standards as cited in appropriate professional journals or reference guides and as directed by the attending veterinarian. We have developed this policy to clarify what we believe must be considered and included in an environment enhancement plan developed under § 3.81 in order to meet the requirement of adequately promoting the psychological well-being of nonhuman primates. We have based this policy on a review of the available primate literature, professional journals and reference guides, and the collective experience of field inspectors, veterinarians, and primatologists.

Dealers, exhibitors, and research facilities who house nonhuman primates will meet the requirements of § 3.81 if they develop and follow an environment enhancement plan (referred to below as "plan") in accordance with this policy. If a plan is not developed in accordance with this policy, the plan may or may not meet the requirements of § 3.81. If a dealer, exhibitor, or research facility wants assurance that an alternative plan (not in accordance with this policy) is in compliance with § 3.81, they may request approval of the plan in writing from the Deputy Administrator of Animal Care.

Based on our research, we have identified five elements that are critical to environments that adequately promote the psychological well-being of nonhuman primates:

A. Social Grouping
B. Social Needs of Infants
C. Structure and Substrate
D. Foraging Opportunities
E. Manipulanda

The remainder of this policy contains what we believe are the currently accepted professional standards to address these five critical elements, based on our research and review of the available literature, as explained above. The first two critical elements, Social Grouping and Social Needs of Infants, are a clarification of § 3.81(a), which deals with the impact of social grouping on psychological well-being. Structure and Substrate, Foraging Opportunities, and Manipulanda are critical elements which clarify § 3.81(b), Environmental Enrichment.

Facilities are encouraged to explore additional elements and innovations and to exceed what is in this policy.

A. Social Grouping

Section 3.81(a) requires that a plan must address the social needs of nonhuman primates of species known to exist in social groups in nature. According to our research, primates are clearly social beings and social housing is the most appropriate way to promote normal social behavior and meet social needs. In order to address the social needs of nonhuman primates under § 3.81(a), the plan must provide for each primate of a species known to be social in nature to be housed with other primates whenever possible. The housing options listed below are listed in a hierarchy of preference, with group housing being the most desirable plan. Housing should maximize opportunities for a full range of species-appropriate contact, except that reproduction may be limited or prevented entirely. Social housing should be designed to reduce the risk of injury from others in the enclosure. Compatibility must be determined as described in 9 CFR 3.81(a)(3). Housing options include:

1. Housing in an enclosure with one or more compatible primates. For group-living species, species-typical groupings are strongly encouraged.

2. Housing in an enclosure without another compatible primate, but with the animal having the opportunity for continuous visual, auditory, olfactory, and tactile contact with another compatible primate (such as through adjacent wire mesh or bars). For primate species in which grooming other primates is an important social function, sufficient tactile contact range is particularly important.

3. Housing without the animal having the opportunity for continuous visual, auditory, olfactory, and tactile contact, but with such contact on a periodic basis, through scheduled social interaction with one or more compatible primates.

4. Housing without the animal having the opportunity for continuous visual, auditory, olfactory, and tactile contact with a compatible primate, but with daily positive interaction with compatible human care givers. The human contact should be of sufficient type and duration to compensate for restricted social housing. We do not consider basic routine husbandry or medical or experimental manipulation to be sufficient human contact.

We consider pair or group housing (Option 1) to be the most desirable housing option and we expect this option to be used whenever possible. We consider this particularly important for chimpanzees, gorillas, gibbons, and siamangs, which seem to suffer particularly from being housed individually. If Option 1 is not utilized, the plan must provide an explanation and justification for each diminished degree of social interaction. Social housing also facilitates important primate behaviors associated with signals that communicate emotional states or other information between individuals. Acceptable reasons for choosing Options 2, 3, or 4 would include:

1. The health and well-being of the individual primate;

2. Documented unavailability of compatible individuals;

3. The scientific requirements of a protocol approved by an Institutional Animal Care and Use Committee (IACUC) (for registered research facilities); or

4. The animal's assignment to an IACUC-approved project that will result in euthanasia or disposition within a short period (normally less than 60 days).

Virtually any social change can be stressful to the nonhuman primates. In order to effectively manage social groups and minimize stress, the plan should include procedures for introduction, separation, and socialization, including minimizing unnecessary separations for established

compatible pairs or groups, whether temporary or permanent, and minimizing the negative effects of necessary separations.

If individual primates are strongly socialized toward humans and distressed by other primates, the plan should provide for daily, extensive positive human interaction in addition to that associated with routine husbandry, medical care, experimental manipulation, training, or exhibition.

Without some socialization to humans, contact with humans becomes an environmental stressor for the primates, over which they have no control. When contact with human facility personnel is a necessary part of the primate's life, the plan must include a program of husbandry conditioning and habituation to human manipulation. This is particularly important for any primate subjected to frequent conscious manipulation or restraint that may cause more than momentary or slight pain or distress, or frequent chemical restraint to accomplish minor procedures or manipulations.

B. Social Needs of Infants

Section 3.81(c)(1) requires that special attention be given to infants and young juveniles. Nonhuman primate infants and their care-giving parents have specific social needs. The psychological well-being of nonhuman primate infants depends on appropriate infant development. In most situations, the optimal environment for infant development is one that allows the infant to remain with its biological mother through weaning in the company of a species-normal social group. Additionally, reproductive success (including reproductive behaviors, fertility, prenatal adequacy, parturition, and parental care) is generally considered to be one of the strongest indicators of psychological well-being in adult captive nonhuman primates.

All facilities with one or more breeding groups of primates should include in their plan a program to ensure species-typical sensory, motor, psychological and social development of infants. The plan should also include criteria for removal of any infants from the care-giving parent(s) if necessary. Separation should be directed by the attending veterinarian or other qualified professional and should be customized to the characteristics of the individual primate.

Infants should not be permanently removed from the care giving parent(s) before an age that approximates the age of infant independence in nature, except where necessary for the health and well-being of the infant or dam.

Although we stress that it is important not to disrupt the bond between the infant and its parents, there may be situations when infants must be separated earlier than is optimal. When infants must be separated from the care giving parent(s) prior to the approximate age of separation in nature, our research indicates that at least the following separation procedures should be included in the plan in order to minimize distress and ensure appropriate sensory, motor, psychological, and social development of the infant:

- Details of separation procedures used to minimize distress for the infant and the care-giving parent(s);
- Details of any hand-raising or fostering practices. There should be specific provisions, in accordance with the professional literature, to provide the infant with a level of sensory, motor, psychological, and social stimulation approximating that which it would receive from its care giving parent(s), natal group and/or peer group under normal circumstances. Hand raising practices that are likely to be detrimental to the development of species-appropriate behavior or to the well-being of the individual at a later time, such as those involving social restriction from primates of their own species, should not be used;
- A suitable surrogate parent for artificially reared monkey or ape infants.

The plan should include a program to develop and maintain species-typical social competence through exposure to peers and/or adults of the same or compatible species. Socialization to humans and to other animals, such as dogs, may be simultaneously maintained when desirable.

C. Environmental Enrichment—Structure and Substrate

The social, developmental, and physical environment are interdependent in ensuring psychological well-being of nonhuman primates. Section 3.18(b) requires that the physical environment in primary enclosures must be enriched by providing means of expressing noninjurious species-typical activities. The most basic components of the physical environment are the enclosure structure (its size, shape, and design) and the substrates within it (flooring, bedding, and furnishings, including perches, nest boxes, etc.). In order to promote psychological well-being for nonhuman primates, primary enclosures for housing and/or exercise need to be of adequate shape and design, and have adequate furnishings, to accommodate species-appropriate behaviors by all inhabitants. Each primate should be able to, at a minimum, engage in:

1. Species-typical postures and positions for resting, sleeping, feeding, exploration, and play;
2. Species-typical locomotion; and
3. Social adjustments.

Primary enclosures should contain elevated resting structures appropriate for the species. The type, number, and orientation of the structures in each enclosure should be appropriate to the number and social arrangement of the animals in the enclosure. Structures should be positioned to facilitate social adjustments and not interfere with normal locomotion.

Primates of species that normally hang from limbs and/or tails should be provided with structures and complexities that enable them to do so comfortably.

Primates of species with long tails should be provided with sufficient vertical space to permit normal upright resting postures without restriction of tail position or placement of the tail outside the enclosure or into waste pans.

Primates of species that normally rest or sleep in cavities, or which are nocturnal or partly nocturnal, should be provided with nest boxes or similar structures. Primates of species that construct nests for sleeping or resting should be provided with artificial or natural nest materials such as hay, browse, or blankets.

Enclosures should be designed, constructed, and furnished so that individual primates may reasonably avoid other individuals or frightening stimuli. Flight distances, visual barriers, and placement of structures such as perches or shelters should be considered during design and furnishing.

Primarily terrestrial species should have access to suitable flooring and resting areas. Patas monkeys should have regular access to large exercise areas that accommodate running.

Primate species that scent-mark should be provided with suitable scent-retaining surfaces. The surfaces may be part of the cage structure, part of cage furniture, or in the form of temporary objects and should be replaced or sanitized as appropriate.

Enclosures should be designed, constructed, and furnished to facilitate social introduction, reintroduction, separation, or temporary restraint.

Aged, physically impaired, or debilitated individuals should be

provided with structures suited to their physical abilities.

D. Environmental Enrichment—Foraging Opportunities

In the wild, nonhuman primates spend a significant proportion of their time foraging for food. "Working" for food is one of the most frequently found species-typical activities for nonhuman primates. Captive nonhuman primates that are not provided with enough time-consuming foraging tasks may self-mutilate, over-groom, or become aggressive.

As part of enriching the physical environment under § 3.81(b), the plan should provide for each primate to have, on a daily basis, some type of time-consuming foraging opportunity. The foraging enrichment can include a wide variety of time-consuming activities. These activities may include providing something as simple as whole fruits or vegetables with high processing time, providing standard monkey biscuits in novel ways to increase food acquisition times, providing more complex types of devices such as puzzle feeders, or scattering food in substrates. Food items and foraging options should be chosen with consideration for the species and abilities of the individuals involved so that each primate can readily obtain its minimum daily nutritional requirements. The diet for each primate should contain a variety of tastes, smells, and textures. Gnawing or gouging wood should be provided for marmosets and tamarins.

For primates on continuously restricted diets as part of medical treatment or experimental protocol, the plan should provide a substitution for foraging, meaning opportunities to engage in time-consuming cognitive activities or foraging involving nonfood rewards (such as ice cubes or toys). The cognitive activities should be voluntary—we do not consider activities that are part of experimental manipulation to be adequate.

E. Environmental Enrichment—Manipulanda

Manipulanda are objects that can be moved, used, or altered in some manner by the primate's hands. Manipulanda can stimulate several senses and permit the animal to experience novelty and a sense of control over part of its environment. Manipulanda have been shown to be effective in increasing species-appropriate behavior and decreasing abnormal behavior.

As part of enriching the physical environment under § 3.81(b), our research indicates that the plan should provide for each primate to have a variety of portable or moveable items for manipulation available to them. The size and type of item(s) and its presentation should be safe and suitable for the species, age, sex, and characteristics of the individuals. The number of items and their presentation should take into account hoarding or aggressive behavior by animals in a social group and changed as often as necessary to maintain appropriate novelty. Primate species that groom others of their own species but must be caged without tactile contact should have daily access to suitable objects or substrates for grooming.

Considerations for Meeting the Critical Elements

There are other criteria which our research showed must be considered in relation to all five critical elements:

- Documentation
- Novelty
- Control over the environment
- Sensory stimulation
- Exemptions
- Individuals in persistent psychological distress.

Documentation

The plan should be designed with consideration for the species, age, sex, health status, rearing, and behavioral history of the primate. The plan should document:

- Scientific justification for all aspects of the plan, including professional journals and reference guides consulted.
- Changes in the facility's primate population.
- Changes in the needs of individual primates.
- Assessments of the effectiveness of the program in promoting species-appropriate behavior.

Novelty

The plan should provide for appropriate levels of novelty in the items or strategies chosen. Novelty is variation in enrichment devices and strategies. Appropriate novelty includes both the physical properties inherent in any object or situation and the timing or duration that the novelty is provided. Novel items should be provided in sufficient quantity and located within the environment so as to be accessible to all primates. The cognitive abilities of primates should be considered in the choice of novelty provided. Novel stimuli should sustain their interest, encourage activity, and redirect inappropriate activity to behaviors appropriate for their species. Each facility should document in its plan how and with what frequency novelty is maintained.

Control Over the Environment

The plan should provide individual primates with the opportunity to exercise control over some aspects of their environment. Complex objects or environments that can be altered or controlled by the animals provide them with enhanced opportunities to utilize their cognitive abilities. Examples of control include opening doors and peep holes, moving indoors or outdoors, and influencing the temperature and lighting in the cage, as well as avoiding noxious stimuli.

Sensory Stimulation

The plan should provide for each of the five senses to be stimulated in a species-appropriate and non-distressing manner. Exemptions may be made for individuals with sensory impairment.

The plan should provide for primates to be given the opportunity to avoid or distance themselves from objects that may be frightening. Levels of stimulation should not be excessive or discernibly distressing, and individuals must have the opportunity to avoid excessive exposure to such stimuli.

Exemptions

In accordance with § 3.81(e), exemptions for individual primates from various aspects of the plan may be made as part of an IACUC-approved protocol. Section 3.81(e) also allows exemptions to be made by the attending veterinarian because of the animals health or condition or in consideration of its well-being. As required by § 3.81(e), the basis for exemptions must be documented. Exemptions should be only to the extent and length of time necessary. Section 3.81(e) requires that exemptions be reviewed at least every 30 days by the attending veterinarian or, for IACUC-approved protocols, at least annually. Exemptions should be reviewed more often if appropriate to the circumstances and should be adjusted as circumstances change. If, due to medical treatment or experimental protocol, a critical element cannot be satisfied, additional enrichment must be provided as compensation.

Individuals in Persistent Psychological Distress

The plan should provide that, for primates in persistent psychological distress, a primate behaviorist or veterinarian with formal training and experience in primate behavior will be consulted.

Done in Washington, DC, this 9th day of May 1999.

A. Cielo,

Acting Administrator, Animal and Plant Health Inspection Service.

[FR Doc. 99–18050 Filed 7–14–99; 8:45 am]

BILLING CODE 3410–34–P

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. 98–NM–220–AD]

RIN 2120–AA64

Airworthiness Directives; Saab Model SAAB SF340A and SAAB 340B Series Airplanes

AGENCY: Federal Aviation Administration, DOT.

ACTION: Supplemental notice of proposed rulemaking; reopening of comment period.

SUMMARY: This document revises an earlier proposed airworthiness directive (AD), applicable to certain Saab Model SAAB SF340A and SAAB 340B series airplanes, that would have required repetitive inspections to detect cracking around certain fastener holes and adjacent areas of the front spar of the horizontal stabilizers; and corrective actions, if necessary. That proposal also would have required cold working of certain fastener holes of the front spar of the horizontal stabilizers, and follow-on actions; and installation of new fasteners, which would have constituted terminating action for the repetitive inspections proposed by that AD. That proposal was prompted by the issuance of mandatory continuing airworthiness information by a foreign civil airworthiness authority. This new action revises the proposed rule by adding repetitive x-ray inspections. The actions specified by this new proposed AD are intended to prevent failure of the front spar due to fatigue cracking around certain fastener holes of the front spar of the horizontal stabilizers, which could result in reduced structural integrity of the airplane.

DATES: Comments must be received by August 9, 1999.

ADDRESSES: Submit comments in triplicate to the Federal Aviation Administration (FAA), Transport Airplane Directorate, ANM–114, Attention: Rules Docket No. 98-NM–220-AD, 1601 Lind Avenue, SW., Renton, Washington 98055–4056. Comments may be inspected at this location between 9 a.m. and 3 p.m., Monday through Friday, except Federal holidays.

The service information referenced in the proposed rule may be obtained from Saab Aircraft AB, SAAB Aircraft Product Support, S–581.88, Linköping, Sweden. This information may be examined at the FAA, Transport Airplane Directorate, 1601 Lind Avenue, SW, Renton, Washington.

FOR FURTHER INFORMATION CONTACT: Norman B. Martenson, Manager, International Branch, ANM–116, FAA, Transport Airplane Directorate, 1601 Lind Avenue, SW., Renton, Washington 98055–4056; telephone (425) 227–2110; fax (425) 227–1149.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in the making of the proposed rule by submitting such written data, views, or arguments as they may desire. Communications shall identify the Rules Docket number and be submitted in triplicate to the address specified above. All communications received on or before the closing date for comments, specified above, will be considered before taking action on the proposed rule. The proposals contained in this notice may be changed in light of the comments received.

Comments are specifically invited on the overall regulatory, economic, environmental, and energy aspects of the proposed rule. All comments submitted will be available, both before and after the closing date for comments, in the Rules Docket for examination by interested persons. A report summarizing each FAA-public contact concerned with the substance of this proposal will be filed in the Rules Docket.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this notice must submit a self-addressed, stamped postcard on which the following statement is made: "Comments to Docket Number 98-NM–220-AD." The postcard will be date stamped and returned to the commenter.

Availability of NPRMs

Any person may obtain a copy of this NPRM by submitting a request to the FAA, Transport Airplane Directorate, ANM–114, Attention: Rules Docket No. 98-NM–220-AD, 1601 Lind Avenue, SW, Renton, Washington 98055–4056.

Discussion

A proposal to amend part 39 of the Federal Aviation Regulations (14 CFR part 39) to add an airworthiness directive (AD), applicable to certain Saab Model SAAB SF340A and SAAB 340B series airplanes, was published as a notice of proposed rulemaking (NPRM) in the Federal Register on February 18, 1999 (64 FR 8029). That NPRM would have required repetitive inspections to detect cracking around certain fastener holes and adjacent areas of the front spar of the horizontal stabilizers; and corrective actions, if necessary. That proposal also would have required cold working of certain fastener holes of the front spar of the horizontal stabilizers, and follow-on actions; and installation of new fasteners, which would have constituted terminating action for the repetitive inspections proposed by that AD. That NPRM was prompted by the issuance of mandatory continuing airworthiness information by a foreign civil airworthiness authority. Fatigue cracking around certain fastener holes of the front spar of the horizontal stabilizers, if not detected and corrected, could result in failure of the front spar and consequent reduced structural integrity of the airplane.

Comments

Due consideration has been given to the comments received in response to the NPRM.

Request To Revise Certain Inspection Requirement of the Proposed Rule

One commenter, the airplane manufacturer, requests that the originally proposed rule be revised to clarify certain requirements. The commenter notes that the originally proposed rule would require, among other things, repetitive eddy current inspections to be accomplished in accordance with Saab Service Bulletin 340–55–033, Revision 04, dated December 1, 1998. The commenter points out that the Saab service bulletin recommends performing both eddy current and x-ray inspections. Under the compliance section of the service bulletin, the general term "NDT inspection" is used. The commenter suggests that either "NDT inspection" or "eddy current and x-ray inspection" be specified in the requirements.

The FAA concurs with this request. The FAA inadvertently omitted the reference to repetitive x-ray inspections in paragraphs (a) and (b) of the proposed AD, and has revised this supplemental NPRM accordingly. Additionally, the reference to x-ray inspections has been added to the cost impact section of this supplemental NPRM. The original cost estimate in the NPRM included all costs associated with both the eddy current and x-ray inspections.

How to Request Materials from the National Agricultural Library (NAL)

The following groups are eligible to send requests for copies or loans directly to NAL:

- Employees of the U.S. Department of Agriculture
- Employees of eligible food and nutrition programs
  To view a list of eligible programs, go to:
  http://www.nal.usda.gov/services/request.shtml#eligibility
- Libraries, organizations, or institutions
  To review the fees for copies/loans and billing information, go to:
  http://www.nal.usda.gov/about/policy/fee.shtml#schedule

If you are in one of the above groups, you may register for a patron ID:
http://agricola.nal.usda.gov/help/requestoffsite2.htm#id

If you are not in one of the groups listed above, you must send your request through the **interlibrary loan service of a library**.

In the United States, possible sources are:
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Outside of the United States, possible sources are:
- Major university, national, or provincial institutions
- AGLINET (Agricultural Libraries Network) libraries;
  To access the AGLINET website, go to
  http://www.fao.org/library/_info_services/Index.asp and select "Partnerships-Networks."

Additional information on NAL's services to libraries and organizations is provided on:
http://www.nal.usda.gov/services/

The National Agricultural Library's Collection Services Branch (CSB) oversees document delivery and interlibrary loan services. CSB's hours of operation are: Monday to Friday (except Federal holidays), 8:30 am to 4:00 pm EST. For additional assistance and information:

E-mail: access@nal.usda.gov
Phone: 301-504-5717
Web: http://www.nal.usda.gov/services/request.shtml

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