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Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995

Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents

*AWIC Resource Series No. 2
September 1995*

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Introduction

Environmental Enrichment Information Resources for Laboratory Animals has been produced jointly by the Animal Welfare Information Center (AWIC) of the U.S. Department of Agriculture's National Agricultural Library (NAL) and the Universities Federation for Animal Welfare (UFAW) in an effort to encourage the implementation of environmental enrichment programs in laboratory animal husbandry. This publication covers birds, cats, dogs, farm animals, ferrets, rabbits, and rodents. The exclusion of non-human primates is deliberate as they are covered in a separate AWIC publication, [Environmental Enrichment Information Resources for Nonhuman Primates: 1987-1992](#).

Various terms are used to describe the welfare requirements of animals in captivity-- "psychological well-being," "ethological" or "behavioral needs," and "environmental enrichment." Whatever the term used, they are essential requirements, not luxuries. Legislation and guidelines in the European Union (EU) and the United States recognize this. The Council Directive of the EU concerning all laboratory animals stipulates that facilities "...should permit the satisfaction of certain ethological needs...." In the United States, the Animal Welfare Act requires facilities to provide exercise for dogs and programs to promote the psychological well-being of non-human primates, while the U.S. Public Health Service *Guide to the Care and Use of Laboratory Animals* encourages "enriching the environment as appropriate to the species...." The literature cited in this bibliography reflects the extent of research that has taken place

in the field of environmental enrichment or deprivation. While offering a useful resource, the bibliography also reveals areas that are lacking in basic information. Consequently, for species about which little information exists, we have provided literature sources on natural and captive behaviors as a foundation for the development of enrichment programs.

Each section of this bibliography is introduced by a paper which provides general background information on the biology of the animals and their currently accepted needs in captivity. It is advisable to refer to all of the contributions. This should act as a starting point for those about to embark on an enrichment project and the citations can then provide further relevant information.

The staffs of the Animal Welfare Information Center and the Universities Federation for Animal Welfare hope that you find this publication to be a useful addition to your laboratory animal resources and welcome any comments for future editions.

How To Use This Document

This publication is divided into 8 sections: articles and bibliographies, journal listing, subscription information for selected journals, organizations, suppliers and products, common devices and programs, subject index, and document delivery information for U.S. and foreign patrons.

Articles and Bibliographies

The primary section of this publication consists of seven subsections broken out by species or class of animal. Each subsection is introduced by an article written by a recognized authority in the field of environmental enrichment or behavior. The reference section for each article may or may not overlap with citations in the bibliographic portion of each subsection. Immediately following each article is a comprehensive bibliography containing citations that are arranged alphabetically according to the last name of the primary author. Each entry also contains descriptors and the NAL Call Number if the particular source is available at the National Agricultural Library (NAL).

[Journal Listing](#)

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

[Subscription Information for Selected Publications](#)

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

[Organizations](#)

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

[Suppliers and Products](#)

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means

exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

[Common Enrichment Devices and Programs](#)

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

[Subject Index](#)

The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *page number* on which the index term can be found.

[Document Delivery Information](#)

The information contained here provides directions on how to obtain copies of articles mentioned in the bibliography. There are separate directions for U.S. patrons and those readers outside the United States. **All patrons are encouraged to use their local resources before contacting the National Agricultural Library.** While the National Agricultural Library provides a variety of services to patrons around the world, videocassettes are not available for loan outside the United States and Canada.

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Environmental Enrichment for Birds

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The following links access AWIC and other chapters in this publication:

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Introduction

Birds of many different species from a wide variety of original habitats are housed in research laboratories. Galliformes such as the quail (*Coturnix coturnix*) and the chicken (*Gallus gallus*) are used in biomedical research in studies of reproductive, digestive and "biological clock" physiology, and in genetic research. Pigeons (*Columba livia*) are stalwarts of the psychological laboratory, used primarily for learning and cognitive studies, whilst diverse species such as budgerigars (*Melopsittacus undulatus*), starlings (*Sturnis vulgaris*) and passerine species (e.g., the great tit, *Parus major*) may also be kept for behavioral research purposes. This diversity makes it difficult to generalize about the specific physical or behavioral needs of laboratory birds, and a preliminary first step should always be to consider the natural behavior of each species in the wild.

Wild quail and jungle fowl (the ancestor of the domestic fowl) live in small social groups, devote much of their day to scratching and foraging for food on the ground, and perform complex sequences of behavior such as dustbathing and pre-laying nesting. In the laboratory they may be housed in aviaries or floor pens, or in cages with varying opportunity to perform these behavioral patterns. The spatial restriction imposed by typical laboratory chicken (50 x 60 x 56cm high) or quail (27 x 36 x 20cm high) cages may restrict even relatively simple movements such as wing-flapping. The pigeon is a more gregarious bird, often found in very large flocks, and capable of flying fast over distances of more than 1000km. In the laboratory pigeons are kept either in aviaries, pigeon lofts, or in cages (typically 44 x 44 x 54cm high).

In most laboratories veterinary supervision is good and careful attention is devoted to hygiene, and to the maintenance of strict temperature and lighting regimes. Despite this care, the welfare of many laboratory birds may be prejudiced in barren or restrictive environments. This may be a particular oversight when the birds are subjects of behavioral or psychological research, as there is some evidence that cognitive abilities may be detrimentally affected by barren housing. It is probably not possible to recreate a completely natural environment for all laboratory birds, but much can be achieved by relatively simple environmental enrichment, especially in conjunction with information about behavioral needs and priorities.

More is known about the welfare requirements of the domestic fowl than any other bird, largely because of research generated by the controversy over agricultural battery cages. Caution is required when generalizing across species, but a number of important points have emerged from this research, relating to both physical and mental well-being, that can be applied to the laboratory situation.

Laying hens are alarmingly prone to bone breakage if they fly into solid structures such as cage walls, or poorly positioned perches. The risk of breakage is exacerbated if bones are weak due to insufficient exercise in spatially restricted housing. Most cages for laboratory birds appear to allow sufficient space for wing stretching, if not for flapping or actual flight, but many birds may avoid stretching their limbs too close to solid walls or partitions. The greatest risk of physical injury will occur if birds become frightened and attempt to escape from their cages, either during catching procedures or simply when disturbed by human presence. It is therefore important to allow sufficient space for running and wing flapping to maintain bone strength, and because these are important behaviors in their own right (Nicol 1987). This freedom must be coupled with the provision of a small, safe catching area. Birds can often be enticed into such areas if they are well lit whilst the rest of the room is temporarily darkened. Protection from injury can also be facilitated by suspending protective nets just below the cage or aviary roof or by lining the cage or catching area (e.g., with fiberglass) and ensuring there are no rough projections.

If fear levels in laboratory-housed birds are low then panic flights leading to physical injury are less likely, and general welfare is improved. New birds should be gradually exposed to the specific sounds or stimuli that they will encounter in the laboratory so that they can habituate. Research on many species, including chickens and quail, has also shown that baseline fear levels can be reduced by providing an enriched environment. Rearing young birds with access to a variety of stimuli such as colored objects and background music appears to have long-term beneficial effects. But, for adult birds, environmental enrichment must do more than simply provide a more complex general environment. It must also provide opportunities for birds to perform high priority behavior patterns. Increasing evidence suggests that functional behavior performance is crucial to good welfare. Even when birds are provided with *ad libitum* food and pre-formed nests, they still need to perform foraging and nest-building behavior. Laying hens are even willing to "pay a cost" to obtain their food by foraging in litter, rather than eat readily available food from a dish.

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Recommendations

Some simple suggestions for the environmental enrichment of laboratory birds include:

1. Allow birds to forage for their food (which should be as varied as possible), either by scattering the food in wood-shavings on the aviary floor, by hiding it amongst shredded paper in a large trough, or by providing it in a form where birds have to work e.g., stuck together in a grain-block. Operant feeders, where a button must be pecked to release food, may occupy solitary birds, but cannot be recommended for group-housed birds as they may not allow birds to feed simultaneously and hence could result in increased competition and risk of feather pecking.
2. Allow egg-laying birds the opportunity to perform nesting behavior by the provision of suitable nest-boxes and building material. If hen or quail have to be kept in cages consider the possibility of modifying the cage to incorporate a roll-away nest box. This can work successfully for laying hens housed in cages (Sherwin 1994).
3. Allow sufficient space for running or flying activity, and consider ways of increasing the value of the space available. Perches or roosting shelves can be incorporated cheaply into all housing systems. In small cages perches can be inserted at night to allow roosting but removed during the day to allow unrestricted space.
4. House birds in suitable stable social groups. If birds must be housed individually arrange the cages so that they have visual contact with others. This may reduce the incidence of stereotypic behavior (Keiper 1970). Since birds seem able to perceive 2-dimensional images the use of mirrors may also reduce the negative effects of social isolation.

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Descriptors: welfare, housing density, crowding, floor space, behavior, group size, cage size, bone strength.

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NAL call number: 47.8 W89

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Descriptors: stocking density, litter, slat floor, foraging, behavior, hens.

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Descriptors: cage, deep litter pen, nest box, preference, hen, flock.

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NAL call number: 47.8 B77

Descriptors: wire floor nest box, rollaway nest box, egg production, nesting behavior, space, cage, nest box, hens.

Appleby, M.C., S.F. Smith, and B.O. Hughes (1992). **Individual perching behaviour of laying hens and its effects in cages.** *British Poultry Science* 33(2):227-238.

NAL call number: 47.8 B77

Descriptors: perch-type preference, perch space, egg quality, crowding, behavior, perch, hens, cage.

Blokhuis, H.J. (August 1986). **Feather-pecking in poultry: Its relation with ground pecking.** *Applied Animal Behaviour Science* 16(1):63-67.

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Descriptors: housing, floor type, feather pecking.

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Descriptors: battery cage, percherries, confinement, exercise, disease.

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NAL call number: SF481.I5

Descriptors: quail, cage, litter, mortality, feed efficiency, mortality.

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Descriptors: quail, cage, litter, production, reproduction.

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NAL call number: 49 J82

Descriptors: fear, stress, battery cages, cage enrichment, cage, hens, body weight, behavior.

Church, J.S., T. Tennessen, and A.B. Webster (1991). **Effects of environmental enrichment and genetic strain on the behaviour of white leghorn pullets.** *Canadian Journal of Animal Science* 71(4):1274.

NAL call number: 41.8 C163

Descriptors: battery cages, breeds, production, cage, pullets, genetics, behavior.

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NAL call number: 47.8 AM33P

Descriptors: handling, housing, genetics, hens.

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NAL call number: 47.8 AM33P

Descriptors: density, hens, fear, egg production, behavior.

Craig, J.V. and J.C. Swanson (1994). **Review: Welfare perspectives on hens kept for egg production.** *Poultry Science* 73(7):921-938.

NAL call number: 47.8 Am33P

Descriptors: chickens, hens, alternative production systems, economic consequences.

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NAL call number: 47.8 AM33P

Descriptors: tonic immobility, avoidance behavior, production, hen, 3-bird cage.

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NAL call number: QL750.A6

Descriptors: feeding, feather-pecking, pullet, cage, floor pen, density.

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Descriptors: competitive, feeding, aggression, dominance, submission, social, cage.

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NAL call number: QL750.A6

Descriptors: hens, dominance, feeding behavior, density.

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NAL call number: 413.8 B534

Descriptors: care, housing, design, captivity, waterfowl, welfare.

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Descriptors: mortality, productivity, hens, feather condition, cages, floor pen.

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Descriptors: preening, feeding, pecking, genetics, cage, hens.

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NAL call number: 47.8 AM33P
Descriptors: dominance, stress, aggressive behavior, housing, density, social, agonistic, fowl.
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Descriptors: tonic immobility, stress, floor pen, cage, hens, avoidance behavior.
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Descriptors: cage, motivation, hens, feather pecking, environmental stimulation, behavior.
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Descriptors: hen, pre-laying behavior, cage, nest, housing, welfare, egg-laying behavior.

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Descriptors: battery cage, litter-reared, nests, social interactions, cage, hens.

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Descriptors: hen, cage, nest, behavior, production, welfare.

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Descriptors: photoperiod, feed conversion, feathering, ring-necked pheasant.

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Descriptors: debeaking, litter floor, wire floor, pullet, corticosterone.

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Enriching the Environment of the Laboratory Cat

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Cats are intelligent, highly specialized carnivores. Like many predators, their senses are highly developed (reviewed by Bradshaw 1992). The cat's ability to hear, see and smell outside our own range give it a very different perception of its environment to ours. For example, it has a second olfactory system, the vomerosensory system which is associated with social behavior. The system is used when cats come into contact with other cats or their urine. In addition, the cat's visual images are supplemented with information from its highly developed sense of balance and sensory hairs on the head and legs which give the cat its position relative to other objects.

The domestic cat, *Felis silvestris catus*, used in laboratories is the same species that is commonly kept as a pet and exists in substantial numbers in feral colonies. Until recently, cats were thought to be essentially solitary but studies have shown they are also found in large socially structured groups (at densities of over 2000 per km² Izawa 1984; Izawa *et al.* 1982; Kerby and Macdonald 1988). The key to the success of the domestic cat is flexibility. Its ability to adapt enables it to survive in environments as diverse as the laboratory cage and isolated islands where individual territories can reach 6 km² (Liberg and Sandell 1988). The rest of this paper introduces the problems of confinement experienced by domestic cats, the principles of enrichment relevant to this species and the role of enrichment in preventing and relieving problems.

Specific problems associated with confinement include boredom, aggression to people and to cats, fearfulness, poor reproductive success, anorexia, tail-chasing, stereotypies, fabric eating and self-mutilation (Mellen 1988; Holmes 1993). It seems that cats confined in relatively restricted environments are more likely to develop behavior problems as Mertens and Schär (1988) claim pet cats restricted to indoors are more likely to be presented for behavior problems than cats with access to outdoors. As single laboratory caging represents the most extreme and barren environment in which cats are confined, it is likely that this is where the worst problems will develop. However, any form of cat housing can be made more stimulating, complex, and less predictable through both environmental and social enrichment.

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Environmental enrichment

Above a critical minimum, improving *quality* of space for cats rather than *quantity* may be a better investment (Mansard 1989). In several species, increasing housing space alone did not change levels of activity (Hite *et al.* 1977; Bebak and Beck 1993). Quality of space can be improved by providing a range of resting places, by extending vertical space, by increasing complexity and by frequently changing internal structure and contents.

Elevated resting places are particularly favored by cats for watching their surroundings. They also preferred resting places that were warm, dry, and protected on one, or even better, two sides (Smith 1990; Roy 1992) and situated in the corners or edges of an enclosure where they can watch without the possibility of being approached from behind (Roy 1992). A range of resting places should be provided so that cats can choose their degree of contact with other cats. This may be particularly important if they are timid or the focus of aggression. The provision of shelves, ropes and climbing poles (illustrated in Loveridge 1984; Horrocks 1994) enrich the enclosure's vertical complexity and extend the available space. The latest advances in enriched group-housing are illustrated in Loveridge's paper (1994). Shelving allows the available space to be separated into functional areas. For example, the areas can be allocated to food, litter, scratch posts, toys, bedding and viewing points. These areas can be changed to promote activity. If shelves are hinged so they can fold down, the internal space periodically can be changed by erecting different combinations of the shelves available. Surface materials commonly used are metal and plastic but cats prefer materials which maintain a constant temperature such as straw, shredded paper, shavings, sacks, clothes or wood (Roy 1992).

Within the available space, furniture and objects can be provided to create a focus of interest, exploration and play. Toys which provide movement and which are frequently changed attract the most interest.

Food has been the focus of enrichment for several other *Felis* species (Mellen *et al.* 1981; Law *et al.* 1990). In laboratories, dry food is particularly suitable for hiding in the enclosure or for placing inside containers which the cat has to work at to extract individual pieces. A cheap version of a food puzzle can be made by gluing together two yoghurt containers containing dry food, with holes just large enough to extract one piece at a time. The puzzle can be made more challenging by hanging the tubs just above the cat's head height. Puzzle boxes for cats are now commercially available. Alternatives include hiding food inside cardboard boxes, in bedding, on shelves and inside rolling toys.

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Social enrichment

The social environment can also improve the quality of time spent confined. Cats vary in their degree of sociability. In colonies where new cats frequently join the group, some cats remain essentially solitary (Roy 1992) whereas others form social attachments which undoubtedly enrich their lives by adding variety and complexity. By providing a variety of retreats and resting places, cats have the opportunity to interact closely with other cats or to remain alone if less sociable.

Social contact with cats

Singly caged cats lack the opportunity that communally confined cats have for rich, interactive relationships. Ideally, cats should remain in stable groups. If research requires single housing, cats can often be returned to social groups in between trials or for a period each day.

Social contact with people

People are also a rich source of stimulation. Many cats respond positively to human social contact. Cats kept in a

relatively restricted environment will seek additional stimulation from people (Turner and Stammbach-Geering 1990) indicating they may derive some benefit from the contact.

If direct contact is not possible, social enrichment can be indirect. Visual, vocal and olfactory communication are possible without direct contact by the use of glass partitions and grills between pens. Access to a communal room in which other cats have previously left chemical messages, rubbed from their glands, or sprayed in their urine, convey information to cats about each other (Natioli 1984). Providing scratch posts enables cats to keep their claws trimmed but also allows them to leave olfactory and visual messages (scratch marks) to other cats in the colony. The sound of voices on radio may habituate timid cats to people (Hurni and Rossbach 1987).

Many problems associated with confinement can be prevented by adequate early socialization and careful selection of cats for suitable temperament (McCune in press; Reisner 1994; McCune *et al.* 1995). One study showed that friendly, confident cats were less distressed by being caged, their normal behavior was less inhibited and they adapted sooner than timid cats (McCune 1992). For cats inadequately socialized as kittens and already stressed by caging, social contact can be an additional stressor. For these individuals, methods other than handling must be used to relieve stress and enrich the captive environment (McCune 1995). Individuals will vary in both their need for enrichment and the benefit it provides them. For example, cats with a timid temperament (McCune 1992), extremes of age (McCune 1994) and restricted experience (Konrad and Bagshaw 1970; Ledger 1993) are more likely to have problems adjusting to confinement and responding to novelty. Mellen (1988) claims that male cats are more likely than female cats to develop problems in restricted environments.

Few of these studies were primarily interested in environmental enrichment. Techniques of enrichment need to be scientifically validated to promote and communicate methods that work for cats and to avoid techniques which produce problems. Assessments should look for a decrease in abnormal behavior and a behavioral repertoire which more closely resembles that of free-ranging cats (UK Cat Behavior Working Group 1995). Research animals without behavior problems are likely to have better welfare and produce better quality data.

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Dogs and Dog Housing

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Brief background

The dog is descended from the wolf, possibly the Southern wolf (*Canis lupus pallipes*). Wolves are social carnivores that can combine into packs, and this trait is still shown by some feral dogs (Feddersen-Petersen 1994). Thousands of years of domestication and artificial selection have produced breeds, with modified social repertoires (Bradshaw and Brown 1990), that are capable of transferring conspecific social behavior to humans. Like most larger mammals, dogs spend a considerable portion of their time inactive (Hubrecht *et al.* 1992, Adams and Johnson 1993). However, as a diet opportunist, the dog is adapted to seeking a wide variety of foods in unpredictable locations, it is therefore much more likely to be tolerant of novel items and circumstances than a more specialized feeder. Conversely, during its active periods it may be more easily bored by a predictable and limiting environment.

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Physical needs

There are many publications that provide recommendations for the dog's general husbandry (e.g., MacArthur 1987, HMSO 1989, 1995). These are based on experience and provide valuable information but there has been very little research into specific physical requirements apart from diet. In most scientific work a tightly controlled environment is required to reduce unwanted variation, however, the dog is a very adaptable animal and a healthy adult can cope with a range of conditions, particularly if it has access to areas with different micro-climates.

Temperature, humidity, ventilation and lighting

An indoor temperature range of 15-24°C, and humidity of 55 percent ± 10 percent, with 8-12 air changes per hour is suitable. New-born puppies require an ambient temperature of 26-28°C for at least the first 10 days of life. Lighting should be adequate for staff to work, and there may be a case for a low level of nocturnal illumination in totally enclosed facilities.

Diet

Dogs appear to prefer meat to cereal diets (Houpt and Smith 1981). Some breeds have a propensity for obesity (Anderson 1973), however, they will usually adapt well to the many proprietary diets available. Advice, if needed, should be sought from the suppliers.

Noise

Dog housing is often very noisy because of barking, and sound pressures of well over 100 decibels have been recorded (Senn and Lewin 1975). Ottewill (1968) provided recommendations to reduce noise, mainly with the aim of improving conditions for the humans. The dog has a hearing frequency range of up to 55 kHz (Gamble 1982) with the most sensitive frequencies at 500Hz -16kHz. At these frequencies their hearing can be up to four times as acute as that of humans. Prolonged exposure to sound pressures of over 90 decibels is known to damage human hearing, and many sites advise or require hearing protection for the staff. It is not unreasonable to assume that such levels might also damage dog hearing, although there is very little evidence on this subject.

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Social needs

It has been known for a long time that inadequate housing can lead to behavioral problems in dogs (Fuller 1967, Solarz 1970). Normal husbandry for the dog should allow plenty of opportunities for social interactions with humans (Wolfe 1992) and conspecifics (Fox 1986). Group housing of compatible dogs in pairs or larger groups is the preferred housing method, (HMSO 1989, Hubrecht *et al.* 1992, Hubrecht 1993b) but care is needed to control any fighting. Regular human contact during the puppie s' socialization period (3-14 weeks) is particularly important to produce dogs that are relaxed with humans (Scott and Fuller 1965).

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Environmental enrichment

Many laboratory enclosures are simple structures, with little or no complexity provided by cage furniture or subdivisions, and in some countries it is still legal and common practice to house dogs in what would seem to be very small cages. It is unlikely that such small enclosures can provide for the dogs' psychological needs (Hetts 1991). A good housing system should allow the dog to exercise an element of choice, to manipulate or chew safe objects, and provide opportunities for human and canine socialization (Hubrecht 1993a). Dogs sometimes have to be housed singly for experimental or quarantine reasons, in which case greater thought should be given to providing extra human contact time and an interesting environment.

Dog pens should be subdivided into separate sleeping and exercise areas which provide complexity, choice and allows the dog to defecate/urinate away from its sleeping area (Fox 1986). Solid partitions between pens provide privacy and help to prevent injuries, but can isolate the dog from its surroundings. A good pen design should allow the occupants to satisfy their natural curiosity about what is happening outside the enclosure. One solution is to provide platforms at a

height that allows the dog to see over the partitions whilst lying down (Hubrecht 1993a). Such devices have the additional advantage of increasing the useable space available to dogs.

There have been a number of studies on the effects of exercise, and pen size (e.g., Campbell *et al.* 1988, Hughes *et al.* 1989, Bebak and Beck 1993, Hetts *et al.* 1992). There is no evidence that providing extra exercise *per se* improves welfare (Clark *et al.* 1991), although walks outside the enclosure are undoubtedly enjoyed.

Olfaction is an important canid sense. We know little about how to enrich an environment through odors but Hubrecht *et al.* (1992) found that dogs housed in groups spend more of their time sniffing and investigating the floor of their enclosure. Dogs will also make extensive use of chews, particularly if they taste of food and are presented properly (DeLuca and Kranda 1992, Hubrecht 1993a).

Breed differences and husbandry requirements should be kept in mind when considering enrichment options. It is also important to remember that dogs vary in temperament (Cattell and Korth 1973) and perhaps also in their housing requirements and ability to cope with a particular kennelling system.

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NAL call number: 442.8 L62

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NAL call number: SF91.A5 1979

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NAL call number: 410.9 P94

Descriptors: welfare, exercise, cage size, cage design.

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Descriptors: dogs, animal housing, environment, laboratory animals.

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Descriptors: separation, behavior, animal care.

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Descriptors: feral, dingo, bonding, social behavior.

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NAL call number: 41.8 AM3

Descriptors: stress, eustress, feeding behavior, reproduction, ACTH, glucocorticoids, sympathetic nervous system, responses.

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NAL call number: QL737.C22C36

Descriptors: dogs, cages, animal welfare, legislation.

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Descriptors: dogs, exercise, stress, lymphocyte transformation, cortisol, animal welfare.

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Descriptors: welfare, well-being, environmental enrichment, social behavior, dogs, cats, rodents, rabbits, primates.

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Descriptors: dogs, animal husbandry, animal housing, animal breeding, animal welfare, socialization.

Case, D.B. (October 1985). **Puppy socialization.** *Veterinary Technician* 6(9):456-457.

NAL call number: SF406.A5

Descriptors: dogs, pups, social behavior, deviant behavior, behavior modification, animal housing.

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Descriptors: animal welfare, animals, dogs, housing, physical fitness, hydrocortisone.

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NAL call number: QL737.C22C36

Descriptors: confinement systems, housing, experimental design, EKG, muscle enzyme, behavior.

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NAL call number: QL750.E74

Descriptors: animal dominance, animal social behavior, animal environments, infanticide, dogs, social density, dominance hierarchy.

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NAL call number: QL55.A1L33

Descriptors: dogs, cats, swine, gumadisc, nylabone frisbee, plastic chain, decoys, gumabone tug, catnip, sheepskin mice, balls, bells, cotton tugs, scented apples.

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Descriptors: service dogs, training methods, early experience.

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Descriptors: behavior, bonding, human isolation, dogs.

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NAL call number: 410.9 P94

Descriptors: dogs, resting area, housing.

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Descriptors: ethology, socialization, exercise, housing, environment, psychological well-being.

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NAL call number: SF406 F69

Descriptors: dogs, primates, rodents, cats, confinement effects, physical activity, stereotypies, cage size, brain development.

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NAL call number: SF406 I52

Descriptors: selective breeding, genotype, handling, socialization, temperament, isolation, exercise.

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NAL call number: 410 B393

Descriptors: intra-species socialization, intra-species, identification, avoidance, recognition, bonding.

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NAL call number: 410.9 P94

Descriptors: review, dogs, rodents, poultry, behavior, social isolation, social stimulation, crowding.

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NAL call number: QL750.A6

Descriptors: social behavior, social organization, domestication, *Canis lupus*, lycaon, effects on dogs.

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NAL call number: QL55.A1L3

Descriptors: dogs, sex differences, hydrocortisone, blood serum, stress, adaptation, environmental factors, susceptibility.

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NAL call number: 41.8 Z5

Descriptors: mouse, rat, guinea pig, rabbit, dog, cat, legislation, behavior, stress, exercise, laboratory animals, animal welfare, cages, housing.

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Descriptors: dog owner's book, toys, games, exercise.

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NAL call number: 410.B77

Descriptors: dogs, stimuli, animal behavior, social behavior, aggression, fear.

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NAL call number: QL55.I5

Descriptors: puppies, laboratory rearing, breeding colony, husbandry, animal welfare.

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Descriptors: socialization, human-animal bond, canines.

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NAL call number: SF406 N32 1985

Descriptors: guidelines, policy, husbandry, facilities, laboratory management.

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NAL call number: QL750.A6

Descriptors: dogs, pens, cages, animal housing, animal behavior, social interaction, isolation, space requirements, animal welfare.

Hetts, S. (March 1991). **Psychologic well-being: Conceptual issues, behavioral measures, and implications for dogs.** *Veterinary Clinics of North America: Small Animal Practice* 21(2):369-387.

NAL call number: SF601.V523

Descriptors: Animal Welfare Act, regulations, history, physical and psychic well-being, measures, indicators, abnormal behavior, normal behavior, preference testing, caging, socialization.

Hite, M., H. M. Hanson, N. R. Bohidar, P. A. Conti, and P. A. Mattis (1977). **Effect of cage size on patterns of activity and health of beagle dogs.** *Laboratory Animal Science* 27(1):60-64.

NAL call number: 410.9 P94

Descriptors: weight gain, activity patterns, standing, lying, sitting, sleeping, electrocardiograph, examinations, ophthalmic, hematologic, biochemical measurements.

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NAL call number: QL750.A6

Descriptors: aggression, mating behavior, young animals, animal behavior, cat, dog, differential rearing.

Hubrecht, R.C. (February 1995). **Enrichment in puppyhood and its effects on later behavior of dogs.** *Laboratory Animal Science* 45(1):70-75.

NAL call number: 410.9 P94

Descriptors: early socialization, human contact, toys, chews, plastic pipe.

Hubrecht, R.C. (1993). **A comparison of social and environmental enrichment methods for laboratory housed dogs.** *Applied Animal Behaviour Science* 37(4):345-361.

NAL call number: QL750.A6

Descriptors: activity pattern, toys, psychological well-being, socialization session.

Hubrecht, R.C. (1993). **Dog Housing and Welfare: UFAW Animal Research Report No. 6**, Universities Federation for Animal Welfare (UFAW): Potters Bar, Herts, UK, 13p.

Descriptors: welfare, behavior, socialization, stereotypes, enrichment, toys.

Hubrecht, R.C., J.A. Serpell, and T.B. Poole (September 1992). **Correlates of pen size and housing conditions on the behaviour of kennelled dogs.** *Applied Animal Behaviour Science* 34(4):365-383.

NAL call number: QL750.A6

Descriptors: dogs, kennels, cage size, animal behavior, shelters, laboratories, social behavior, animal housing, animal welfare.

Hughes, H.C., S. Campbell, and C. Kenney (July 1989). **The effects of cage size and pair housing on exercise of beagle dogs.** *Laboratory Animal Science* 39(4):302-305.

NAL call number: 410.9 P94

Descriptors: dogs, animal housing, cage size, cage density, exercise, animal welfare, regulations.

Hughes, H.C. and S. Campbell (1990). **Effects of primary enclosure size and human contact.** In: *Canine Research Environment* J.A. Mench and L. Krulisch, eds., Scientists Center for Animal Welfare: Greenbelt, MD, pp. 66-75.

NAL call number: QL737.C22C36

Descriptors: dogs, laboratory animals, animal housing, socialization, animal welfare.

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Descriptors: Animal Welfare Act, exercise, environmental enrichment, space recommendations, feeding, water, enclosures.

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NAL call number: 11 AC82

Descriptors: cage size, body weight, feed intake, tameness score, fur quality.

Korhonen, H., M. Harri, and L. Nurminen (Autumn 1986). **Effects of social competition for feed on growth of farmed raccoon dogs**. *Growth* 50(3):340-350.

Descriptors: dogs, competitive behavior, physiology, feeding.

Korhonen, H. (1988). **Activity and behavior of farmed raccoon dogs**. *Scientifur* 12(1):27-37.

NAL call number: SF402 S3

Descriptors: circadian activity, behavioral patterns, rhythms, eating, elimination, aggression, environmental conditions.

Kuhn, G. and W. Hardegg (1988). **Effects of indoor and outdoor maintenance of dogs upon food intake, body weight, and different blood parameters**. *Zeitschrift für Versuchstierkunde* 31(5):205-214.

NAL call number: 410 Z36

Descriptors: environment, red blood cell counts, packed cell volume, hemoglobin, plasma enzymes, substrates, minerals.

LaBarge, L. (1977). *The pet house book: How to build housing, accessories, and playthings for your dogs, cats, birds, lizards, hamsters, and other pets*. Butterick Pub.: New York, NY, 200p.

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Descriptors: pets, housing, design and construction, pet supplies, building, amateurs' manuals, handicraft.

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NAL call number: QL750.A6

Descriptors: human sex differences, animal sex, familiarity.

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Descriptors: excessive grooming, stone chewing, wool sucking, polydipsia, barking, tail or foot biting, aggression, environmental enrichment.

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NAL call number: QH301 C63

Descriptors: wolves, animal social behavior, social isolation, handling, infants (animal).

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Descriptors: genetics, behavior, breed differences, exercise.

Markwell, P.J. and C.J. Thorne (November 1987). **Early behavioural development of dogs**. *The Journal of Small Animal Practice* 28(11):984-991.

NAL call number: 41.8 J8292

Descriptors: socialization period, responses to environment, sensory isolation, play.

Milnes, S. (February 1992). **Danger from toys?** *Veterinary Record* 130(8):168.

NAL call number: 41.8 V641

Descriptors: dog, tongue injury, playthings, case report.

Netto, W.J., J.A. van der Borg, and J.F. Slegers (April 1992). **The establishment of dominance relationships in a dog pack and its relevance for the man-dog relationship.** *Tijdschrift voor Diergeneeskunde* 117(Supplement 1):51S-52S.

NAL call number: 41.8 T431

Descriptors: bonding, posture, behavior, social dominance.

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NAL call number: Z5055 U49D53

Descriptors: dogs, animal environments, environmental stress, animal ethology.

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NAL call number: 410.9 P94

Descriptors: physical activity, specific activity measurements, body weight, blood chemical and urine values.

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NAL call number: 410.9 P94

Descriptors: exercise, dog, cage confinement, musculoskeletal system, dogs kept in cages, muscle, enzymes.

O'Farrell, V. (1991). **Behavioural problems in companion animals.** In: *Managing the Behaviour of Animals* P. Monaghan, D. Wood-Gush, eds., Chapman and Hall: London and New York, pp. 233-252.

NAL call number: QL751 M218 1990

Descriptors: pets, behavior, management, reviews.

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NAL call number: 41.8 V6456

Descriptors: exercise, aggression, human-animal bond.

Pettijohn T.F., T.W. Wong, P.D. Ebert, and J.P. Scott (1977). **Alleviation of separation distress in three breeds of young dogs.** *Developmental Psychobiology* 10(4):373-381

NAL call number: QP351.D4

Descriptors: Shetland sheepdogs, telomians, beagles, food, toys, human contact, canine contact, distress vocalizations, isolation.

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NAL call number: QH301 C63

Descriptors: aggression, crowding, dominance, eating, spatial behavior.

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NAL call number: QP351.D4

Descriptors: social attachment, beagles, Telomians, separation distress.

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NAL call number: 41.8 P882

Descriptors: housing, husbandry, animal welfare, dog, pets.

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NAL call number: 447.8 P564
Descriptors: legislation, physical conditioning, dogs, housing, primates.
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NAL call number: SF601 N4
Descriptors: definitions, measurement, parameters, coping, adaptation, stress psychology.
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Descriptors: dogs, education, socialization with humans, age differences.
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NAL call number: 41.2 H198 [1976 No. 72]
Descriptors: dissertation, animal housing, animal welfare, cage, dog.
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NAL call number: 410 Z36
Descriptors: dogs, animal housing, movements, dark, light, kinetic energy.
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NAL call number: 41.8 So8
Descriptors: disease susceptibility, separation stress, mortality, weight gain.
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NAL call number: aZ5071.N3 no.94-24
Descriptors: bibliography, behavior, welfare, stress, nutrition, exercise.
- Swanson, J.C. (October 1991). **Exercise for Dogs.** *Special Reference Briefs* 92-02 U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 24p.
NAL call number: aS21.D27S64 no.92-02
Descriptors: bibliography, regulatory issues, physiology, behavior, husbandry, standard values.
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NAL call number: Videocassette no. 2040
Descriptors: stress, handling, relaxation, training, behavior, body awareness.
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NAL call number: 41.8 K67
Descriptors: cages, animal welfare, zootechny, dog, animal housing, laboratory animals.
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NAL call number: 447.8 J825

Descriptors: dog, training, heart rate, blood circulation, exercise, heart, atropine.

Unshelm, J. (1993). **Keeping dogs and cats in conditions which comply with animal welfare with the support of behavioral advice and therapy.** *DTW Deutsche Tierärztliche Wochenschrift* 100(2):65-69.

NAL call number: 41.8 D482

Descriptors: housing, behavior, companion animals.

Unshelm, J. (February 1993). **Raising dogs and cats in compliance with animal welfare using advice on behavior therapy.** [Tiergerechte haltung von hunden und katzen durch erhaltensberatungen und verhaltenstherapie.]

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NAL call number: 41.8 D482

Descriptors: animal welfare, behavior, cats, dogs, housing.

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NAL call number: QL55.A1L33

Descriptors: puppies, socialization, human-animal bond, toys.

Vanderlip, S.L., J.E. Vanderlip, and S. Myles (March 1985). **A socializing program for laboratory-raised canines.**

Lab Animal 14(1):33-36

NAL call number: QL55.A1L33

Descriptors: behavior, temperament testing, toys, knotted towel, plastic bottles, food rewards.

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NAL call number: HV4704 A46 1989

Descriptors: exercise, stress, bonding, human interaction.

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NAL call number: QL737.C22C36

Descriptors: psychological well-being, exercise, socialization, management, performance vs. engineering standards.

Wright, J.C. (1980). **The development of social structure during the primary socialization period in German shepherds.** *Developmental Psychobiology* 13(1):17-24.

NAL call number: QP351 D4

Descriptors: social organization, exploratory behavior, ontogeny, dominance, dogs.

Wright, J.C. (1983). **The effects of differential rearing on exploratory behavior in puppies.** *Applied Animal Ethology* 10(1-2):27-34.

NAL call number: QL750.A6

Descriptors: hand-rearing, litter-rearing, stimulus, exploratory behavior, locomotor activity, novel objects, reactivity, social environment, rearing, exploratory behavior, dogs.

Wubs, W. and H. Rozemond (October 15, 1987). **Experimental dog: A need for improvement in housing.** [Proefhonden: Noodzaak tot verbetering van de huisvesting.] *Tijdschrift voor Diergeneeskunde* 112(20):1182-1190.

NAL call number: SF601 N4

Descriptors: animal welfare, laboratory animals, physiology, dogs, housing, standards, quality control.

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Enrichment for Farm Animals

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There has been relatively little published on environmental enrichment for the mammalian farm animals used in "laboratory" studies. This may be partly because most such studies are carried out either in normal farm conditions, or in conditions regarded as similar to these (for example, growing pigs housed singly, similar to normal housing for sows) or on animals removed only temporarily from such conditions. There may, however, be welfare problems in normal farm conditions and the considerable work which has now been done on improvement of these is relevant here. In addition, the special treatment necessary for experimental work may cause further problems and also cast doubt on the results of the research, not least when imposed temporarily. In this brief commentary, three aspects of such treatment will be considered which act separately and in combination: human contact, social conditions and physical conditions.

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Human contact

Animals react to human contact behaviorally and physiologically in ways which may interfere with the topic under study. This is particularly likely if restraint is involved; for example, to obtain blood samples. A common approach to minimize such effects is to use remote sampling methods such as filming behavior, strapping on or implanting heart rate meters (Porges 1985), and automatically withdrawing blood samples from a catheter (Mayes *et al.* 1988). Other non-invasive techniques are also being developed, such as measurement of hormones in saliva, urine and faeces. Less

attention has been given to the possibility of accustoming animals to human contact including handling, which may considerably reduce such effects (Pearce *et al.* 1989), despite the fact that more is known about this for farm animals than for other species (Gonyou 1991). A particularly promising finding is that pigs and sheep can be trained to enter a restraining device for procedures including blood withdrawal voluntarily and repeatedly (Grandin 1986, 1989). Another important aspect of human contact is predictability (Carlstead 1986). Thus if feeding times are to be manipulated experimentally, animals can be trained in advance not to expect food at the same time each day (Reid and Mills 1962). As a general rule it is better to accustom animals to disturbance than to attempt to avoid disturbing them; if there is little disturbance for long periods then any disruption which does occur may be very stressful. This is probably the main basis of the idea which is sometimes expressed that animals should be subjected to "adequate levels of stress".

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Social conditions

Many experiments involve isolation of animals. This can have very strong effects: heart rate of sheep when first isolated is greatly elevated (Baldock and Sibly 1986) and sheep on restricted diets behave more abnormally in isolation than in groups (Done-Currie *et al.* 1984). There is some indication that the chance of conception by dairy cows is lower if they have been kept in isolation prior to artificial insemination (cf. Moberg 1991). Effects are usually reduced if animals can see each other and it should be possible to arrange this even in restrictive housing such as metabolism crates. More consideration should also be given to methods for housing animals in groups while making individual measurements; for example, using film (Pajor *et al.* 1991) or electronic devices (Lambert *et al.* 1983) for recording individual food intake. When animals are housed in groups, though, care must be taken to minimize harmful social behavior such as aggression, as in any husbandry system. Precautions should include careful consideration of physical conditions.

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Physical conditions

The space provided in experimental conditions is usually less constrained than that in commercial conditions with one major exception: the metabolism crate. This is commonly used to keep the animal in a fixed position for collection of urine and faeces, but more use could be made of bags fixed to the animal for this purpose; in pigs, it should also be possible to make use of their habitual urination and defecation sites as has been done for cats (Carlstead *et al.* 1993). Reactions of animals to close confinement may be extreme especially if it is combined with food restriction (Appleby *et al.* 1987). In experiments which do not use such crates, problems such as harmful social behavior and frustration of various behavior patterns are more likely to be associated with barrenness of the environment than with lack of space. Common causes for barrenness are cleanliness and avoidance of unwanted edible material (such as straw). Yet cleanliness is not always strictly necessary, and an acceptable degree of cleanliness may be achieved even with substrates such as woodchips (Chamove *et al.* 1982). The environment can be made more complex quite easily, for example by fitting barriers (Waran and Broom 1993) and providing manipulable objects. Many techniques which have been developed for other species such as primates could also be used for farm animals; these include, for example, increasing the animals' control over their physical environment (Baldwin 1979). Among other advantages, provision of "toys" makes handling of pigs easier (Grandin *et al.* 1987). It should be pointed out, however, that the effects of environmental enrichment need to be assessed rather than just assumed; there may be deleterious effects such as increased aggression (McGregor and Ayling 1990). Food can also be provided in ways which are more stimulating than a trough, such as operant devices. As with several of the other factors already mentioned, this will be particularly valuable if food is restricted. Without such measures, food restriction can have severe effects on behavior (Willard *et al.* 1977, Appleby and Lawrence 1987) with implications for physiological effects on the measurements being made (Marsden and Wood-Gush 1986). Such effects include extreme variability: one nutritional study of sheep which kept them without food for a period to obtain baseline measurements found that some reacted violently, with high metabolic

rate, while others were somnolent with low metabolism (Blaxter and Wainman 1961).

Environmental enrichment for farm animals in experiments is important both for the validity of the experiments and for the animals themselves.

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Farm Animal Bibliography

General

- Berry, D.J. (1994). **Transport and Handling of Livestock and Poultry: January 1984 - January 1994.** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 62p.
NAL call number: aZ5071.N3 no. 94-32
Descriptors: bibliography, livestock, poultry, handling, husbandry, transport, care.
- Cregier, S.E. (1989). **Farm Animal Ethology: A Source Book.** Captus Press: Ontario, Canada, 213p.
NAL call number: SF81 C73
Descriptors: directory, information, journals, funding sources, academia, audio-visuals, conferences, books, reviews.
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NAL call number: QL55 A1L33
Descriptors: canine, swine, feline, welfare, exercise, toys, play, balls, runs, comparisons.
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NAL call number: QL55 A5
Descriptors: behavioral needs, comfort, shelter, flooring, legislation.
- Fox, M.W. (1965). **Environmental factors influencing stereotyped and allelomimetic behavior in animals.** *Laboratory Animal Care* 15(5):363-370.
NAL call number: 410.9 P94

Descriptors: boredom, crowding, space, noise, photoperiod.

Grandin, T. (April 1993). **The effect of previous experiences on livestock behavior during handling.** *Agri-Practice* 14(4):15-20.

NAL call number: SF601.B6

Descriptors: cattle, sheep, handling, restraint, behavior.

Grandin, T. (November 1990). **Design of loading facilities and holding pens.** *Applied Animal Behaviour Science* 28(1/2):187-201.

NAL call number: QL750.A6

Descriptors: cattle, pigs, sheep, floor, lighting, chutes, pens, transport.

Grandin, T. (July 1987). **Animal handling.** *The Veterinary Clinics of North America: Food Animal Practice* 3(2):323-338.

NAL call number: SF601.V535

Descriptors: livestock, handling, stress, movement, behavior, facilities.

Grandin, T. (June 1984). **Reduce stress of handling to improve productivity of livestock.** *Veterinary Medicine and Small Animal Clinician* 79(6):827-831.

NAL call number: 41.8 M69

Descriptors: cattle, physiology, stress, behavior.

Hart, L.A. (February 1994). **Opportunities for environmental enrichment in the laboratory.** *Lab Animal* 23(2):24-27.

NAL call number: QL55 A1L33

Descriptors: zoo, farm, laboratory, outdoor housing, noise.

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Descriptors: calves, behavior, housing, stables, slatted floors, pens, microclimate.

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Descriptors: corrals, chutes, headgates, enclosures, stress, behavior.

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NAL call number: 41.8 V643

Descriptors: social behavior, age, housing.

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Descriptors: behavior, flight distance principle, human-animal bond, mutual confidence.

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NAL call number: QL55 I44

Descriptors: flight distance, avoidance, feral horses, domestic horses, psychobiology, researcher personality.

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Descriptors: behavior, social interaction, herd structure, sex differences.

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Descriptors: behavior, colt, fillies, mating behavior, mares.

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NAL call number: SF955.E6

Descriptors: behavior, welfare, care, health, handling, well-being.

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Descriptors: foals, behavior, running, exercise, socialization.

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NAL call number: 410 B77

Descriptors: social behavior, husbandry, grooming, stress.

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NAL call number: HV4701.A34

Descriptors: foals, adaptability, domestication, behavior, welfare, training.

Heird, J.C., D.D. Whitaker, R.W. Bell, C.B. Ramsey, and C.E. Lokey (1986). **The effects of handling at different ages on the subsequent learning ability of 2-year-old horses**. *Applied Animal Behaviour Science* 15(1):15-25.

NAL call number: QL750.A6

Descriptors: behavior, learning, training, novel stimuli, conditioning, maze-learning.

Hogan, E.A., K.A. Houpt, and K. Sweeney (September 1988). **The effect of enclosure size on social interactions and daily activity patterns of the captive Asiatic wild horse (*Equus przewalskii*)**. *Applied Animal Behaviour Science* 21(1/2):147-168.

NAL call number: QL750.A6

Descriptors: *Equus caballus przewalskii*, wild animals, housing, space requirements, socialization, behavior.

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NAL call number: SF411.A57

Descriptors: aggression, behavior, handling, care, treatment, welfare.

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NAL call number: QL750 A6
Descriptors: social behavior, feeding behavior, stress, newborn, foals, solitary confinement, pasture, familiarity, contact, space, grazing, novel environment.
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NAL call number: SF951.E62
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NAL call number: 49.J82
Descriptors: social environment, physical environment, operant conditioning, lighting, preferences, behavior.
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Descriptors: behavioral problems, vices, feeding behavior, mating behavior, group interaction, tractability, animal welfare, time allocation.
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Descriptors: welfare, social behavior, learning, stereotypies.
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Descriptors: *Equus caballus przewalskii*, social behavior, housing, husbandry, facilities, zoological gardens, space requirements.
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NAL call number: SF756.7.I5
Descriptors: social behavior, feeding behavior, housing, space, size.
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Descriptors: saddle horses, housing, animal needs, livestock, work animals, preferences.
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NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, pastured, grazing.
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NAL call number: SF321 N5
Descriptors: animal behavior, group dynamics, social behavior, exercise, field size, pastured, grazing.
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NAL call number: QL750.A6
Descriptors: behavior, isolation, socialization, pastures, open housing, stalls, stress.
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NAL call number: SF951.J65
Descriptors: isolation, stalls, cortisol, stress, disease, adrenal glands, haemoglobin, thyroid hormones, mitogens, lymphocyte transformation, environment, housing, haematology, immune response, age differences.
- Mal, M.E., C.A. McCall, K.A. Cummins, and C. Newland (1992). **Influence of early handling on subsequent learning abilities in weanling horses.** *Journal of Animal Science* 70 (Supplement 1):156(abstract).
NAL call number: 49 J82
Descriptors: abstract, foal, behavior, care, management, livestock, stress.
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Descriptors: weaning, stress, hydrocortisone, concentration, immunity, behavior, blood plasma, separation.
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Descriptors: horses, environment, enrichment, foraging, abnormal behavior.
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NAL call number: SF951.E62
Descriptors: disease, animal behavior, animal welfare, housing, feeding exercise, training, abnormal behavior, stimuli, positive reinforcement, learning.
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Descriptors: learning ability, training.
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Descriptors: behavioral principles, psychology, handling, care.
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NAL call number: Z5055 U49D53
Descriptors: theses, adaptation, training, behavior, stress, neuroleptics.
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NAL call number: HV4704.A54

Descriptors: environment, stress, welfare, sports, isolation, space, socialization.

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NAL call number: SF955.E6

Descriptors: social behavior, wild horses, wild burros, social structure.

Rifa, H. (January 1990). **Social facilitation in the horse.** *Applied Animal Behaviour Science* 25(1/2):167-176.

NAL call number: QL750.A6

Descriptors: *Equus caballus*, maternal behavior, social behavior.

Smith, C.P. (1994). **Housing, Husbandry, and Welfare of Horses: January 1988-January 1994.** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 62p.

NAL call number: aZ5071.N3 no.94-22

Descriptors: bibliography, flooring, stress, housing design, ventilation, temperature control, transport, social environment.

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Descriptors: training, handling, stress, human-animal bond, learning, total body recognition, vices..

Tellington-Jones, L. and U. Bruns (1988). **An Introduction to the Tellington-Jones Equine Awareness Method: The T.E.A.M. Approach to Problem-free Training** Breakthrough Publications: Millwood, NY, 180p.

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NAL call number: SF955.E6

Descriptors: intensive husbandry, foal, social behavior.

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NAL call number: SF309.H6

Descriptors: repetition, training, handling, varied routine.

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NAL call number: 41.8 D482

Descriptors: animal needs, welfare, management, semi-natural environment, shelter, social behavior, comfort behavior.

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NAL call number: 41.8 T445

Descriptors: stables, animal health, metabolic changes, humidity, environment, temperature, ammonia concentrations.

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Sheep and Goats

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NAL call number: QL750.A6

Descriptors: isolation, handling, transport, stress, heart rate.

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Descriptors: housing, environmental temperature, feed intake, production.

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Descriptors: Nubian goat, Alpine goat, social isolation, fear, vocalization, behavior.

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Descriptors: swine, behavior, housing, litter, stress, exploratory behavior, comparison, individual stalls, group housing, behavioral effects, growth rates.

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Descriptors: stalls, tether, housing, welfare.

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Descriptors: abstract, swine, welfare, housing, litter, injuries, weight gain.

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Descriptors: straw, housing, husbandry, behavior, production.
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Descriptors: behavior, raised decks, straw bedding, rooting, chewing, social activity.
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NAL call number: 49 J82

Descriptors: stress, husbandry, fear, enrichment devices.

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Descriptors: pigs, play, toys, games, behavior, welfare, performance.

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Descriptors: socialization, husbandry, handling, human-animal bond.

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NAL call number: SF391.3 A87

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Descriptors: litter, building material, round bales, environment, housing, husbandry, piglets, costs, dietary supplement.

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NAL call number: 41.8 T345

Descriptors: thesis, piglets, sows, behavior, socialization, housing.

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Descriptors: pigs, socially reared, pen size, aggression, injuries, activity, performance, immune response.

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Descriptors: swine, sows, environment, hydrocortisone, housing, stress, welfare, behavior, sexual maturity.

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Descriptors: animal behavior, pig housing, boars, handling, stress factors, growth.

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Descriptors: comparative study, swine, behavior, intensive housing, animal health, environmental factors.

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Descriptors: farrowing crate, preference testing, floor space.

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Descriptors: conference paper, abstract, socialization, isolation, aggression, behavior.

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Descriptors: bibliography, behavior, handling, transport, slaughter, housing.

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Descriptors: mating behavior, growth rate, feed consumption, soundness, group housing, isolation.

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Descriptors: sows, group housing, computerized feeding system, transponders.

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Descriptors: pigs, gilts, foraging device, Edinburgh Football, diets, welfare, feed dispensers, enrichment.

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NAL call number: 49 AN55

Descriptors: group housing, production, neurobiology.

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NAL call number: 49 J82

Descriptors: livestock, space requirements, social stress, group size.

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The Effects of Environmental Enrichment in Ferrets

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Environmental enrichment and impoverishment are relative terms. We can measure them with reference to the normal keeping environment of laboratory animals or to the environment of their wild counterparts; in doing so we might form quite different conclusions. The environment of the average laboratory animal is clearly less complex than that of its wild counterpart, yet for many burrow-living species the average amount of visual and auditory stimulation may be higher in the laboratory (Milligan *et al.* 1993), and this is especially true during rearing. On the other hand the ready provision of food in all seasons, and the protection from both conspecific aggression and predation may make a good laboratory environment less stressful than a natural one if assessed on a life-time basis.

The ferret is a close relative of the polecat (*Mustela putorius*) and has been domesticated for 2000 years. It is widely kept as a working animal for use in trapping rabbits and is an increasingly popular laboratory animal: small enough to keep easily in the laboratory and relatively easy to breed and handle.

Social environment and impoverishment must always be measured with reference to the development stage of an animal and the environment in which this usually occurs. Feral ferrets are essentially solitary and nocturnal, but in captivity show much diurnal activity and individuals may be kept together, although males are often intolerant when in breeding condition. Keeping breeding males apart may reduce stress, but depriving ferret kits of conspecifics during the first month of life when much time is spent in play clearly impoverishes. By analogy with the rat (Potegal and Einon 1989, Morgan 1976, Einon and Sahakian 1983, Einon 1980) such impoverishment could alter later social interaction, sexual behavior, learning, drug tolerance, activity and body size. However as yet there has been little investigation of any of these questions in ferrets.

Most work on lifetime environmental enrichment and impoverishment has been carried out with rats and mice, work on ferrets has largely concerned the provision of objects and conspecifics for play during development. Exceptions include work by Korhonen and colleagues (Korhonen and Harri 1990, Korhonen *et al.* 1992) who examined the effects of differing housing regimes on body weight and pelt quality, concluding that males housed singly had poorer pelt quality than males raised in groups, but that large, all male groups weighed less. Floor space used in housing also influenced pelt quality. They suggest that cages containing one male and one female produces the best pelt size and quality. If body weight and pelt quality reflect the health of animals then this is the optimal housing outside the breeding season. They found that social status correlated with weight; but whether this is causal is unclear. The authors also found that

balls and bite cups reduced skin biting. The addition of "toys" to ferret cages is certainly desirable. Other work suggests that changing these toys on a day-to-day basis has advantages.

Where ferrets are kept in cages which restrict movements there are skeletal changes especially of the hind limbs (Slesarenko 1986), and in a related species social impoverishment has been found to induce more stereotyped behavior (Bildsøe *et al.* 1990). In hot climates there are reports that restriction, crowding and captivity may itself be stressful (Gazizov 1987). Heat stress, and such severe restriction of movement reflect poor husbandry, but while such work is of less relevance in countries with controls upon animal housing, giving ferrets and other mustelids access to space for exercise is clearly important. We should bear in mind that while the whole surface of a cage can provide a "gym" for young mice and rats, ferrets do not swing and climb in the same way.

Chivers and Einon (1982) found that some of the isolation induced effects on behavior which had been shown in rats also occurred in ferrets. Specifically, deprivation of rough and tumble social play caused hyperactivity which persisted into adulthood. Rats deprived in this way also showed poor reversal of previously learned tasks (Morgan 1976), increased susceptibility to amphetamine (Einon and Sahakian 1983) and poor spatial memory (Einon 1980). The fact that a group of socially reared ferrets whose environment was enriched with a series of changing tube systems (Weiss-Buerger 1981) were superior in maze learning and reversal, suggests that they may respond in a similar fashion. Chivers and Einon also showed that the isolation induced deficits in object exploration found in rats were absent in ferrets raised in isolation. The way in which ferrets manipulate objects is influenced by rearing environment. Russell (1990) found that isolated ferrets raised in enriched conditions (with a daily change of play objects) would choose the arm of a maze leading to the more prey-like of two play objects; were superior in capturing both crickets and moving prey-models, and that more elaborate prey-catching responses were elicited from enriched than impoverished animals when placed with dummy objects and remote controlled fur-covered toy cars. Captive as compared to laboratory rearing (Miller *et al.* 1990) also affects predatory skills, particularly the location of prey.

In conclusion although little work has been carried out on impoverishment and enrichment in ferrets, investigations so far suggest impoverishment, whether physical restriction, social or in manipulation of objects has wide ranging effects; especially when imposed during rearing.

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Descriptors: polecat, mink, play, behavior, biting.

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Descriptors: polecat, housing, space cages, growth, pelt quality, husbandry, social groups.

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Descriptors: ferret, male, female, prepubertal play, toys, endocrine control, age factors.

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NAL call number: 410 B77

Descriptors: ferret, activity, endocrine system, behavior, circadian rhythms.

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NAL call number: 410 Z35

Descriptors: ferret-polecat hybrid, behavior, play, tubes, learning, maze.

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Descriptors: ferret, male, female, breeding, behavior.

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NAL call number: 410.9 P94

Descriptors: ferret, diet, behavior, breeding.

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Rabbits

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This short paper introduces the general housing and husbandry of laboratory rabbits. The behavior of wild rabbits is compared with that of their laboratory counterparts, and consideration is given to their behavioral needs from the welfare point of view as well as to the effects of husbandry on scientific research.

The natural environment

The wild rabbit is gregarious, living in family groups in natural colonies or warrens (Cowan 1987). Rabbits spend most of their time underground in burrows during the diurnal period and venture above ground at night when they are generally more active, feeding mainly at dawn and dusk (Mykytowycz 1958). Females dig burrows to prepare nests for the protection of their young which are born helpless and blind; they also serve as a haven in an emergency (Cowan and Bell 1986). In terms of their social activities, stable breeding groups are formed with linear hierarchies of both males and females (Mykytowycz 1958, Cowan 1987). Once stabilized, the order of dominance is generally sustained and fighting is rare (Mykytowycz and Rowley 1958, Lockley 1961); the social organization being controlled by scent marking and territorial patrols which involve chin-marking from cutaneous glands, urination, defecation, and behavioral displays. Male rabbits naturally distance themselves to avoid conflict (Mykytowycz 1958) while females will only fight to compete for burrows if they are in limited supply (Kunkele 1992). Social behaviors include allogrooming and group foraging activities. Rabbits adopt "look-out" positions for potential predators and foot-thumping serves as an alarm signal to alert the colony (McFarland 1987), from which the rabbits run at high speeds for cover, often leaping and jumping obstacles in the process.

Observations on domestic rabbits have shown that there are few differences in their behavior compared with their wild counterparts (Mykytowycz and Hesterman 1975, Bell 1984) so it remains likely that the potential for the full range of behavior of wild rabbits is still present genetically, despite some selection for physical, physiological and behavioral

traits.

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The laboratory environment

Whilst the quality and quantity of laboratory bred rabbits have improved over the past 40 years or so, their psychological well-being has largely been neglected. Advances have included genetic selection for clearly defined pure-bred strains, such as New Zealand Whites, Dutch and Lops, with traits for docility, reproductive performance and growth as well as a vastly improved health status. Other improvements include a standardized complete diet, and a protected and standardized environment of caging, ventilation, lighting, temperature and humidity (Clough 1982). However, such standardized cage designs have evolved mainly for the ease of husbandry and economic considerations, and it is apparent that some of these designs have had undesirable effects on the animals, particularly a reduction in space (Gunn and Morton 1994). Physical and social isolation offers no mental stimulation (Huls *et al.* 1991). Furthermore, the constant feeding of a highly refined pelleted diet is likely to be monotonous (BVAAWF/FRAAME/RSPCA/UFAW 1993). There is evidence that all of these have led to both physiological (Lehmann 1984, Wieser 1984) and psychological problems. Caged rabbits also show behavioral abnormalities including stereotypies (Stauffacher 1992, BVA AWF/FRAAME/RSPCA/UFAW 1993) which may be signs of discomfort, mental suffering and distress (Lawrence and Rushen 1993, Gunn 1994) even though the animals are able to grow and reproduce. There is an ethical mandate to improve the animal's well-being (Broom 1988, Wemelsfelder 1984). It is important to minimize suffering not only for welfare reasons, but also because such "suffering" may result in a range of physiological or psychological changes which could add unintentional variables to the experimental design and affect the accuracy and reliability of the scientific results (BVAAWF/FRAAME/RSPCA/UFAW 1993, Gunn 1994). This in turn may lead to more animals being used in research than is necessary.

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Conventional housing for rabbits

For many years rabbits have been housed in purpose-built metal cages. Single caging isolates rabbits from physical and visual contact and prevents any social interaction, particularly in solid-walled cages (Gunn 1994, Huls *et al.* 1991). They also restrict movement (with minimal floor area (Gunn and Morton 1994, BVAAWF/FRAAME/RSPCA/UFAW 1993) and height) so that rabbits are unable to perform normal ambulation or rearing activities (Gunn and Morton 1994, BVAAWF/FRAAME/RSPCA/UFAW 1993). The barren environment provides no stimulation which leads to abnormal behavior patterns such as bar-biting and clawing of the cage (Stauffacher 1992, Gunn and Morton 1994). These stereotypic activities substitute for natural behaviors which are denied by standard laboratory conditions (Stauffacher 1992) and may indicate frustration, anxiety or boredom, and develop in stages involving a progressive narrowing of the behavioral repertoire (Gunn 1994). A lack of exteroceptive stimulation, restricted movement and social inhibition are reported to be initial causal factors (Dantzer 1986). Other indicators of boredom have been observed such as hunched posture (Gunn and Morton 1994), inertia (Metz 1984), and a staring coat and dull eyes which may also indicate poor health (Wallace *et al.* 1990). As the caged environment is not sufficient to permit an adequate level of physical activity, caged rabbits can develop osteoporosis (Lehmann 1984) and back-bone distortions (Wieser 1984), and a high percentage of intestinal disorders (Jackson 1991) may be a result of "caging stress".

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Welfare and behavioral needs

It is no longer considered acceptable to only provide for animals' physiological needs or to provide conditions which maximize productivity (Dawkins 1980). The care of captive animals should also include consideration of their behavioral needs. Some behaviors which are essential to the animal's well-being are not provided for in the laboratory, such as allogrooming, digging for the purpose of nest-building (Podberscek *et al.* 1991), and foraging (Stauffacher 1992). The inability to perform certain behaviors is thought to lead to intention movements, or inappropriate or abnormal behaviors (Dantzer 1986, Lawrence and Rushen 1993). Subjective states, such as boredom and frustration, can be evaluated through the use of careful experimental design. Other abnormal activities include under- or over-grooming and eating, leading to a staring coat, hair-balls (intestinal stasis - Jackson 1991), weight loss and obesity, respectively. These conditions are commonly observed in singly caged rabbits (BVA/WF/FRAME/RSPCA/UFAW 1993, Gunn 1994). Such behaviors are maladaptive and provide clear evidence of a need for some environmental improvement. These activities are often associated with apathy and a refusal to respond which are indicative of psychological disorders and show a lack of adaptation rather than a coping strategy (Lawrence and Rushen 1993).

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Improvements in rabbit housing

The natural social organization of this species should influence how we house rabbits in laboratories. Since wild rabbits live in groups containing at least one other rabbit of the same sex (Cowan 1987), it seems sensible to suggest that they should at least be housed in pairs, with the exception of mature males (unless they have been castrated - Gunn 1994). Whether grouping rabbits in pairs in cages, in floor pens, or in breeding groups, they should have opportunities for "exercise" and social interaction (BVA/WF/FRAME/RSPCA/UFAW 1993, Batchelor 1991), allowing them more control over their immediate environment. As they are social animals they mix well at an early age, although there may be problems with removal or replacement of adults in an established group (Hammond and Love 1989, Love and Hammond 1991). Males can also be group-housed until they reach sexual maturity, but may then have to be castrated to be housed successfully in stable groups for lengthy periods. If rabbits must be caged individually for experimental reasons, enriching the cage environment has been shown to be beneficial. The cages should be, as a minimum, large enough to enable the rabbits to sit upright and lie out at full stretch (Gunn 1994), have visual contact with other rabbits, an area to withdraw to, a shelf for resting on (Stauffacher 1992) as well as an improved visual field. The provision of roughage such as hay (Gunn 1994), and straw, a varied diet and objects to gnaw on (Stauffacher 1992) or manipulate (e.g., wooden shapes - Huls *et al.* 1991) have been suggested to alleviate boredom and stereotypic activities (Brooks *et al.* 1993, Gunn 1994) and thus substantially improve welfare. Some of these enrichments apply equally to rabbits grouped in pens. It is recommended from an animal welfare point of view that whenever possible rabbits should be group-housed (Home Office 1989, Batchelor 1991) unless the experimental design prohibits it.

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Descriptors: rabbits, rats, noise, behavior.

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NAL call number: QL750 A6

Descriptors: genetics, maintenance behavior, locomotion, comfort, investigatory behavior, stereotypes.

Podberscek, A.L., J.K. Blackshaw, and A.W. Beattie (1991). **The effects of repeated handling by familiar and unfamiliar people on rabbits in individual cages and group pens.** *Applied Animal Behaviour Science* 28(4):365-374.

NAL call number: QL750 A6

Descriptors: rabbit-human interaction, fear, habituation, housing, handling, familiarity.

Rabillard, J.L. (1985). **The behavior of rabbits during breeding and experimentation.** *Stal Sciences et Techniques de l'Animal de Laboratoire* 10(3):209-212.

Descriptors: Aggressive behavior, litters, stress, human interaction, breeding, experimentation.

Rothfritz, P., K. Loeffler, and B. Drescher (October 1992). **The effects of different housing systems on the structure of cancellous bones of Chinchilla and New Zealand White rabbits.** *Tierärztliche Umschau* 47(10):758.

NAL call number: 41.8 T445

Descriptors: movement, vertebrae, hypoplasia, cages, housing, cancellous bone.

Rothfritz, P., K. Loeffler, and B. Drescher (1992). **Effect of housing and exercise on the structure of spongy bone of the ribs, thoracic vertebrae and lumbar vertebrae of laboratory and broiler rabbits. IV. [Einfluss unterschiedlicher haltungsverfahren und bewegungsmöglichkeiten auf die spongiosastruktur der rippen sowie brust und lendenwirbel von versuchs und fleischkaninchen. 4. Mittelung.]** *Tierärztliche Umschau* 47(10):758-768.

NAL call number: 41.8 T445

Descriptors: cage size, hypoplasia, husbandry, welfare, housing, exercise, spongy bone.

Sandford, J.C. (1986). *The Domestic Rabbit*. Collins Professional and Technical: London, UK, 272 p.

NAL call number: SF453 S33 1986

Descriptors: housing, breeding, equipment, industry, genetics.

Scholtyssek, S. and K. Eissele (1986). **Keeping rabbits at different housing densities. [Die haltung von kaninchen in unterschiedlicher besatzdichte.]** *Zuchtungskunde* 58(2):142-147.

NAL call number: 49 Z8

Descriptors: housing, food consumption, crowding, weight gain, density.

Stauffacher, M. (1992). **Group housing and enrichment cages for breeding, fattening, and laboratory rabbits.** *Animal Welfare* 1:105-125.

NAL call number: HV4701.A557

Descriptors: legislation, welfare, breeding, single cages, paired housing, near-to-nature conditions, pup area, nesting area, commercial housing, social groups, spatial conditions.

Stauffacher, M. (1992). **Rabbit breeding and animal welfare: New housing concepts for laboratory and fattening**

rabbits. *DTW (Deutsche Tieraerztliche Wochenschrift)* 99(1):9-15.

NAL call number: 41.8 D482

Descriptors: breeding groups, caging, legislation, behavior, welfare, housing, floor area, stereotypes, sexual behavior, breeding.

Stavy, M., A. Goldblatt, and J. Terkel (March 1985). **Home odor preferences in young hares (*Lepus capensis syriacus*): Effects of age and role of maternal presence.** *Developmental Psychobiology* 18(2):125-139.

NAL call number: QP351 D4

Descriptors: home cage odor, strange cage odor, preference testing, avoidance, age, social relationships, maternal presence.

Vastrade, F.M. (1987). **Spacing behavior of free-ranging domestic rabbits (*Oryctolagus cuniculus*).** *Applied Animal Behaviour Science* 18(2):185-196.

NAL call number: QL750 A6

Descriptors: social relationships, colony management, distance, husbandry, behavior, free-range, spacing behavior.

Whary, M., R. Peper, G. Borkowski, W. Lawrence, and F. Ferguson (March 1993). **The effects of group housing on the research use of the laboratory rabbit.** *Laboratory Animals* 27:330-341.

NAL call number: QL55 A1L3

Descriptors: exercise, social contact, group housing, single housing, environmental enrichment, behavior.

Wyly, M.V., V.H. Denenberg, D. DeSantis, J. K. Burns, and M.X. Zarrow (March 1975). **Handling rabbits in infancy: In search of a critical period.** *Developmental Psychobiology* 8(2):179-186.

NAL call number: QP351 D4

Descriptors: psychology, social activity, exploratory activity, open-field test, handling, infancy.

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Environmental Enrichment in Rodents

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"Environmental Enrichment in Rodents" is a chapter from: Smith, C.P. and V. Taylor (September 1995).

[Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents](#). *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 145-212.

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Environments of laboratory animals have often been designed on the basis of economic and ergonomic aspects, with little or no consideration for animal welfare. Laboratory housing conditions can deprive animals the possibility of performing a full repertoire of normal behavior. As a response to this lack of stimulation animals may show abnormal behaviors, such as stereotypies or passiveness (Wemelsfelder 1990).

The living conditions and therefore the well-being of captive animals can be improved through environmental enrichment. Environmental enrichment can be defined as altering the living environment of captive animals in order to provide opportunities to express more of their natural behavioral repertoire. It is widely acknowledged that allowing animals to perform the widest possible range of behaviors is likely to be beneficial and, furthermore, providing environmental enrichment has been shown to reduce stereotypic behavior in captivity (e.g., bank voles: Ödberg 1987).

The environment of an animal consists of a wide range of stimuli, including the social environment of conspecifics, conspecifics and humans, and the physical environment such as the cage and its contents ([See Figure 1](#)). Currently used caging for rodents restricts various behaviors (O' Donoghue 1993) and it is recommended that the cage environment should be improved to cater for physiological and ethological "needs" including resting, grooming, exploring, hiding, searching for food, and gnawing.

[Note: Figure 1 is not available in electronic format. Caption: "Stimuli in the environment of laboratory animals

(Baumans 1994)." Stimuli listed are: 1) Cage Size Structure Accessories, 2) Conspecifics, 3) Contrspecifics, 4) Humans, 5) Auditory Visual Olfactory Tactile, and 6) Nutrition.]

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Social environment

Conspecifics, contrspecifics, and humans

The social environment of animals can be enriched by housing them together with conspecifics in pairs or in groups. This will only be successful if the groups or pairs formed are harmonious and stable. Mice and rats are social animals and often housed in groups, although this is not a natural situation for the males. In some strains, especially in mice, aggression may be a problem and the males need to be separated. In contrast, hamsters are not social, which eventually can lead to problems when housing such animals together.

Housing together several animal species in the same room is often common practice. It is not known whether contrspecifics housed in one animal room are affected by the olfactory and auditory cues from each other. Humans are part of the social environment of laboratory animals and handling the animals is a very important aspect of this daily care routine. It is also beneficial to train animals to become used to routine handling and procedures (Biological Council 1992).

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Nutritional environment

Supply and type

In the wild, rodents spend a major proportion of their time searching for and consuming food. In the laboratory food is mostly provided *ad libitum* and easily obtained by the animals. For enrichment purposes food items can be scattered in the substrate or bedding so that the animals spend time searching for it. Carder and Berkowitz (1970) found that rats preferred earned food although free food was available, when the work demands were not too high. For hamsters who naturally hoard their food, scattering food pellets into the cage is an easy source of stimulation.

The type of food given to laboratory animals is usually standardized in the form of pellets but additional food such as hay or straw can be supplied to satisfy the need for roughage.

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Sensory environment

Auditory, visual, olfactory and tactile

Sensory enrichment can be provided in many forms. Animals such as guinea pigs, which are easily frightened, react to noises in their environment; a radio which plays softly during the day can mask sudden background noises.

In many animal facilities, light intensity is usually too high. This may have deleterious effects on eyes such as retinal degeneration (Williams *et al.* 1985), especially in albinos. Rodents, who are essentially nocturnal animals, should be given the opportunity to hide from light.

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Psychological environment

Control of the environment

It is important that animals have a certain degree of control over their environment, as a lack of control may cause stress. Rats reared in an environment in which they could control lighting, food and water supply were less emotional compared to controls (Joffe *et al.* 1973). In the laboratory cage the possibilities for animals to control their environment are restricted. However providing a shelter or refuge gives them the opportunity to withdraw from frightening stimuli outside or inside their cage as well as hide from too much light. Plastic tubes (Peters and Festing 1990) or old drinking bottles (Ward and DeMille 1991) are simple solutions for shelters.

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Physical environment

Cage size, structure and accessories

Sometimes enlarging the available space for an animal can enhance well-being. Small cages may increase the incidence of stereotyped movements and other non-locomotor abnormal behaviors (Ödberg 1987). Enlarging the available space can be achieved by providing climbing accessories, shelters/refuges and exercise devices. When mice were given a divided cage with a bedding section and a wire mesh section, they deposited almost all excreta on the wire mesh floor, thus keeping their sleeping area clean (Blom 1993).

Nesting material such as tissues, hay or wood-wool enables rodents to perform nest-building behavior. Softwood sticks can be provided to guinea pigs for manipulation and gnawing (Sharmann 1991).

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Evaluation of an enrichment program

When introducing enrichment to an animal's environment, it is very important to evaluate the enrichment program used, by assessing whether or not the animals respond to the enrichment and maintain interest.

Assess baseline behavior; introduce enrichment; monitor behavior; analyze responses; long term effects

Reactions of the animals to the enrichment should be monitored and compared with baseline behavior, which was

assessed before introduction of enrichment. An increase in species-typical behavior or a decrease in abnormal behavior may be seen. Different strains of animals can respond differently to enrichment as has been observed in mice (van de Weerd *et al.* 1994). It is also important to assess whether the changes in behavior are short or long term effects, as the animals may be interested in the enrichment for a short period only. Physiological variables can also be monitored to assess responses to changes in laboratory environments, e.g., body-weight, heart rate, hormonal levels, immune status and reproductive function (Markowitz and Line 1990).

When introducing enrichment in the laboratory, costs and the practical use of enrichment items are also important. Objects introduced into the cage should be stimulating for the animals, but they should also be easy to remove, clean, and replace, so that personnel are willing to work with them. If it is clear to those responsible for animals that environmental enrichment is beneficial to the animals, their motivation to work with and to improve the enrichment program should increase.

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- Joffe, J.M., R.A. Rawson, and J.A. Mulick (1973). **Control of their environment reduces emotionality in rats.** *Science* 180:1383-1384.
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Technology: Journal of the Institute of Animal Technology 42(3):149-156.

Wemelsfelder, F. (1990). **Boredom and laboratory animal welfare.** In: *The Experimental Animal in Biomedical Research, vol I*, B.E.Rolin, ed., CRC Press: Florida, pp. 243-272.

Williams, R.A., A.G. Howard, and T.P. Williams (1985). **Retina damage in pigmented and albino rats exposed to low levels of cyclic light following a single mydriatic treatment.** *Current Eye Research* 4(2):97-102.

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Rodent Bibliography

Gerbils and Hamsters

Arnold, C. and S. Gillaspay (1994). **Assessing laboratory life for golden hamsters: Social preference, caging selection, and human interaction.** *Lab Animal* 23(4):34-37.

NAL call number: QL55 A1L33

Descriptors: hamster, Golden, male, socialization, solitary nature, caging, Habitrail tunnels, bedding, handling, group housing.

Borer, K.T., A. Pryor, C.A. Conn, R. Bonna, and M. Kielb (1988). **Group housing accelerates growth and induces obesity in adult hamsters.** *American Journal of Physiology* 255(1 pt.2):R128-R133.

NAL call number: 447.8 Am3

Descriptors: hamster, Golden, female, adult, isolation, socially reared, bedding, body weight, body fat.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.

NAL call number: QL55 I5

Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Cheal, M.L. (1987). **Environmental enrichment facilitates foraging behavior.** *Physiology and Behavior* 39(2):281-283.

NAL call number: QP1 P4

Descriptors: gerbil, adult, old, locomotor activity, outdoor experience vs. laboratory rearing, novel objects, odors, food.

Cheal, M.L. (1987). **Lifespan environmental influences on species typical behavior of *Meriones unguiculatus*.** In: *Evolution of Longevity in Mammals. A Comparative Approach*, A.D. Woodhead and K.H. Thompson, eds. Plenum Press: New York, NY, pp.145-159.

NAL call number: QP85 B73

Descriptors: gerbil, body weight, lifespan, behavior.

Cheal, M.L., K. Foley, and R. Kastenbaum (1986). **Brief periods of environmental enrichment facilitate adolescent development of gerbils.** *Physiology and Behavior* 36(6):1047-1051.

NAL call number: QP1 P4

Descriptors: gerbil, male, female, motor behavior, somatic growth, seizures, indoor vs. outdoor.

Fischer, R.B. and P.S. Brown (1993). **Vaginal secretions increase the likelihood of intermale aggression in Syrian hamsters.** *Physiology and Behavior* 54(2):213-214.

NAL call number: QP1 P4

Descriptors: hamster, male, female, social environment, vaginal odors.

Hsu, C.H. and C.S. Carter (1986). **Social isolation inhibits male-like sexual behavior in female hamsters.** *Behavioral and Neural Biology* 46: 242-247.

NAL call number: QH301 C63

Descriptors: hamster, Golden, female, group housing, weaning age.

Hull, E.M., C. Kastaniotis, G. L'Hommedieu, and J. Franz (1976). **Environmental enrichment and crowding: Behavioral and hormonal effects.** *Physiology and Behavior* 17(5):735-741.

NAL call number: QP1 P4

Descriptors: gerbil, male, female, weanling, adult, crowding, social interaction, cortisol, testosterone, testes weight, adrenal weight, behavior, reproduction.

Martin-Ramirez, J. and D.I. Onyekwere (1993). **Play fighting in Golden Syrian hamsters: Influence of age, sex, and social isolation.** *Aggressive Behavior* 19(1):65-66.

NAL call number: BF575 A3A57

Descriptors: hamster, Golden Syrian, male, isolation, play.

McClure, D.E. and J.L. Thomson (1992). **Cage enrichment for hamsters housed in suspended wire cages.** *Contemporary Topics* 31(4):33 (abstract).

NAL call number: SF405.5 A23

Descriptors: hamster, aggression, anorexia, cotton nestlets, wire cages, PVC pipe, toys, seclusion.

Norris, M.L. and C.E. Adams (1979). **Vaginal opening in the Mongolian gerbil, *Meriones unguiculatus*: Normal data and the influence of social factors.** *Laboratory Animals* 13(2):159-162.

NAL call number: QL55 A1L3

Descriptors: gerbil, male, female, cage density, body weight, vaginal opening, age.

Onyekwere, D.I. and J.M. Ramirez (1993). **Play fighting versus serious fighting in golden hamsters (*Mesocricetus auratus*).** *Bulletin of the Psychonomic Society* 31(6):503-506.

Descriptors: hamster, Golden, young, isolation, aggression.

Pellis, S.M. and V.C. Pellis (1993). **Influence of dominance on the development of play fighting in pairs of male Syrian Golden hamsters--*Mesocricetus auratus*.** *Aggressive Behavior* 19(4):293-302.

NAL call number: BF575 A3A57

Descriptors: hamster, Syrian Golden, male, weanling, young, adult, aggression, submission, play, rat.

Tang-Martinez, Z., L.L. Mueller, and G.T. Taylor (1993). **Individual odors and mating success in the golden hamster, *Mesocricetus auratus*.** *Animal Behaviour* 45(6):1141-1151.

NAL call number: 410 B77

Descriptors: hamster, Golden, female, male, olfaction, pheromones, litter size, pregnancy rate.

Thomas, E.M., M.E. Jewett, and I. Zucker (1993). **Torpor shortens the period of Siberian hamster circadian rhythms.** *American Journal of Physiology: Regulatory, Integrative and Comparative Physiology* 265(4):R951-R956.

NAL call number: 447.8 Am3

Descriptors: hamster, Siberian, male, ambient temperature, body temperature, gonadectomized, running wheel, body mass.

Van den Broek, F.A.R., H. Klompmaker, R. Bakker, and A.C. Beynen (May 1995). **Gerbils prefer partially darkened cages.** *Animal Welfare* 4(2): 119-123.

NAL call number: HV4701 A557

Descriptors: housing, preference test, light intensity, Mongolian gerbils.

Guinea Pigs

Bailey, K.J., D.B. Stephens, and C.E. Delaney (1986). **Observations on the effects of vibration and noise on plasma ACTH and zinc levels, pregnancy and respiration rate in the guinea pig.** *Laboratory Animals* 20: 101-108.

NAL call number: QL55 A1L3

Descriptors: guinea pig, female, pregnant, nonpregnant, transport simulator, ACTH, zinc.

Berryman, J.C. (1981). **Guinea pig responses to conspecific vocalizations: Playback experiments.** *Behavioral and Neural Biology* 31(4):476-482.

NAL call number: QH301 C63

Descriptors: guinea pig, female, neonate, lactating, virgin, behavior, silence, nonvocal sounds, communication, maternal behavior.

Berryman, J.C. (1978). **Social behaviour in a colony of domestic guinea pigs: Aggression and dominance.** *Zeitschrift für Tierpsychologie* 46(2):200-214.

NAL call number: 410 Z35

Descriptors: guinea pig, male, female, behavior, activity, social group, dominance, aggression, vocal communication.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.

NAL call number: QL55 I5

Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Coulon, J. (1971). **Influence of social isolation on the behavior of guinea pigs (Influence de l'isolement social sur le comportement du cobaye.** *Behaviour* 38(1-2):93-120.

NAL call number: 410 B393

Descriptors: guinea pig, male, female, isolation, maternal care, exploratory behavior, activity, play, open-field behavior.

Coulon, J. (1973). **Social relationships of domestic male guinea pigs. 2. The agonistic behavior on their territory. [Les relations sociales chez le cobaye domestique male. II. Le comportement agonistique interterritorial.]** *Behaviour* 53(3-4):200-216.

NAL call number: 410 B393

Descriptors: guinea pig, male, dominance, aggression, behavior, territory.

Dayal, V.S. and J.K. Bhattacharyya (1986). **Cochlear hair cell damage from intermittent noise exposure in young and adult guinea pigs.** *American Journal of Otolaryngology* 7: 294-297.

Descriptors: guinea pig, male, female, weanling, adult, auditory stimuli.

Hennessy, M.B. and L. Moorman (1989). **Factors influencing cortisol and behavioral responses to maternal separation in guinea pigs.** *Behavioral Neuroscience* 103(2):378-385.

NAL call number: QP351 B45

Descriptors: guinea pigs, male, female, maternal separation, isolation, cortisol, inanimate surrogates.

Plank, S.J. and R. Irwin (1966). **Infertility of guinea pigs on sawdust bedding.** *Laboratory Animal Care* 16(1):9-11.

NAL call number: 410.9 P94

Descriptors: guinea pig, male, female, reproduction, bedding.

Pye, A. (1987). **Comparison of various short noise exposures in albino and pigmented guinea pigs.** *Archives of Oto-Rhino-Laryngology* 243: 411-416.

Descriptors: guinea pigs, noise.

Sascher, N. (1986). **The effects of longterm isolation on physiology and behavior in male guinea pigs.** *Physiology and Behavior* 38: 31-39.

NAL call number: QP1 P4

Descriptors: guinea pig, male, female, isolation, group-housed, body weight, tyrosine hydroxylase, activity, aggression.

White, W.J., M.W. Balk, and C.M. Lang (1989). **Use of cage space by guinea pigs.** *Laboratory Animals* 23: 208-214.

NAL call number: QL55 A1L3

Descriptors: guinea pig, male, female, spatial behavior, caging, activity.

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Mice

Ahroon, J.K. (1977). **The effects of environmental switchovers between enrichment and impoverishment on brain and behavior in mice.** *Dissertation Abstracts International* 37(7-B):3668.

NAL call number: Z5055.U49 D53

Descriptors: mouse, environmental enrichment, impoverishment, open field, activity.

Ardila, R., M. Rezk, R. Polanco, and F. Pereira (1977). **Early handling, electric shock, and environmental complexity: Effects on exploratory behavior, "emotionality," and body weight.** *Psychological Record* 27(1):219-224.

Descriptors: mouse, Swiss, aversive stimuli, environmental enrichment, darkness, handling, open field, defecation, activity.

Bartos, L. and P.F. Brain (1993). **Physiological responses to social status and housing conditions in male mice subject to food competition tests.** *Bollettino di Zoologia* 60(3):293-296.

NAL call number: 410 B63

Descriptors: mouse, male, testes, prostate, adrenal gland, stress.

Baumans, V., F.R. Stafleu, and J. Bouw (1987). **Testing housing system for mice-the value of a preference test.** *Zeitschrift für Versuchstierkunde* 29:9-14.

NAL call number: 410 Z36

Descriptors: mouse, female, caging, preference testing, shelter.

Beynan, A.C. and G. Van Tintelen (1990). **Daily change of cage depresses mass gain in mice.** *Zeitschrift für Versuchstierkunde* 33:106-107.

NAL call number: 410 Z36

Descriptors: mouse, male, female, cage changing, weight gain, activity.

Boehm, G.W., N.S. Waters, G.F. Sherman, G.D. Rosen, D.M. Bradway, B.J. Hoplight, A.M. Galaburda, and V.H. Denenberg (1993). **Environmental enrichment, neocortical ectopias and behavior in BXSb mice.** *Society for Neuroscience Abstracts* 19(1-3):184.

NAL call number: QP351 S6

Descriptors: mouse, learning, behavior.

Bouchon, R. and B. Will (1982). **Effects of post-weaning rearing conditions on learning performance in "dwarf" mice. [Effets des conditions d'elavage apres le sevrage sur les performances d'apprentissage des souris "dwarf."]** *Physiology and Behavior* 28(6):971-978.

NAL call number: QP1 P4

Descriptors: mouse, dwarf, locomotor activity, learning.

- Bouchon, R. and B. Will (1982). **Effects of early enriched and restricted environments on the exploratory and locomotor activity of dwarf mice.** *Behavioral and Neural Biology* 35(2):174-186.
NAL call number: QH301 C63
Descriptors: mouse, weanling, dwarf, open-field, habituation, behavior.
- Bouchon, R. and B. Will (1983). **Effects of post-weaning environment and apparatus dimension on spontaneous alternation as a function of phenotype in "dwarf" mice.** *Physiology and Behavior* 30(2):213-219.
NAL call number: QP1 P4
Descriptors: mouse, DW/Orl-dw, inbred strain, male, maze, spatial information, behavior.
- Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.
- Brain, P. (1975). **What does individual housing mean to a mouse?** *Life Sciences* 16(2):187-200.
NAL call number: 442.8 L62
Descriptors: mouse, isolation, caging, socially reared, adrenal medullary function, adenocortical function, reproduction, neurochemistry, defeat experiments, review.
- Bronson, F.H. (1984). **The adaptability of the house mouse.** *Scientific American* March: 116-125.
NAL call number: 470 Sci25
Descriptors: mouse, running wheel, burrow, reproduction, foraging, temperature, social cues, behavior, review.
- Chamove, A.S. (1989). **Cage design reduces emotionality in mice.** *Laboratory Animals* 23(3):215-219.
NAL call number: QL55 A1L3
Descriptors: mouse, caging, partitions, activity, stress, adrenal glands, behavior, complexity.
- Corridi, P., F. Chiarotti, S. Bigi, and E. Alleva (1993). **Familiarity with conspecific odor and isolation-induced aggressive behavior in male mice (*Mus domesticus*).** *Journal of Comparative Psychology* 107(3):328-335.
NAL call number: BF671 J6
Descriptors: mouse, Swiss CD-1, isolation, olfaction, agonistic behavior, dominance.
- Cummins, R.A., T.N. Carlyon, and R.N. Walsh (1978). **Drug-modulated behavioural responses to environmental enrichment.** *Psychopharmacology* 58(2):197-199.
Descriptors: mouse, Quackenbush albino, male, strychnine, chlorpromazine, activity, socialization.
- Cummins, R.A., P.J. Livesey, and J.A. Bell (1982). **Cortical depth changes in enriched and isolated mice.** *Developmental Psychobiology* 15(3):187-195.
NAL call number: QP351 D4
Descriptors: mouse, neonate, weanling, aging, occipital cortex, neuronal development, metabolic activity.
- Diaz, J.-L. (1988). **Brain weights correlate with behavioral parameters in individual inbred mice housed in a common and enriched environment.** *Behavioral and Neural Biology* 50(2):164-183.
NAL call number: QH301 C63
Descriptors: mouse, BALB/c, young, maze, open field, exploration, aversive response, swimming, induced grooming, whole brain, cerebellum, brain stem, diencephalon, telencephalon, prosencephalon.
- Elliott, R.A. (1970). **Some anatomical and behavioral effects of environmental enrichment on genetically heterogenous mice selectively bred for high and low brain weight.** *Dissertation Abstracts International* 31(4-B):2302-2303.
NAL call number: Z5055.U49D53
Descriptors: mouse, cortex, discrimination tasks.
- Engellenner, W.J., C.R. Goodlet, R.G. Burrig, and P.J. Donovick (1982). **Environmental enrichment and**

restriction effects on reactivity, exploration and maze learning in mice with septal lesions. *Physiology and Behavior* 29(5):885-893.

NAL call number: QP1 P4

Descriptors: mouse, Binghamton, heterogenous, male, handling-reactivity test, open-field, water-maze, learning, behavior.

Erikson, D.J. and T.N. Meacham (1973). **Effects of increased space deprivation on reproductive performance of female ICR-albino mice.** *Publication - Extension Division of Virginia Polytechnic Institute and State University* 153:56-59.

NAL call number: S543.V5V5

Descriptors: mouse, ICR-albino, female, prebreeding, postbreeding, embryo survival, density, corticosteroids.

Eveleigh, J.R. (1993). **Murine cage density: Cage ammonia levels during the reproductive performance of an inbred strain and two outbred stocks of monogamous breeding pairs of mice.** *Laboratory Animals* 27(2):156-160.

NAL call number: QL55 A1L3

Descriptors: mouse, BALB/c, TO, CD-1, Laboratory Animal Breeders Association Guidelines, housing, male, female, breeding, litter size.

Falke, H.E. and H.P. Til (1985). **Effect of polychlorophenols in sawdust bedding on some biotransformation parameters in the liver of mice.** *Netherlands Journal of Agricultural Science* 33(3):314-316.

NAL call number: 12 N3892

Descriptors: mouse, male, female, weanling, liver weight, P-450 enzymes, polychlorophenols, bedding.

Ferrer, I. et al.. (1983). **Morphological changes in the cerebral cortex of mice subjected to enriched and impoverished environments and its later reversal. [Cambios morfológicos en la corteza cerebral de ratones sometidos a medios enriquecidos y a medios empobrecidos en estímulos sensoriales y su posterior recuperación.]** *Archivos de Neurobiología* 46(3):177-182.

Descriptors: mouse, visual cortex, maze, neuronal plasticity.

Goodlet, C.R., W.J. Engellenner, R.G. Burright, and P.J. Donovan (1982). **Influence of environmental rearing history and postsurgical environmental change on the septal rage syndrome in mice.** *Physiology and Behavior* 28(6):1077-1081.

NAL call number: QP1 P4

Descriptors: mouse, Binghamton, heterogenous, septal lesions, handling reactions.

Guastavino, J.M. and G. Goodall (1985). **Permanency of gait improvement induced by vestibular stimulation in the mutant mouse staggerer.** *Journal of Neurogenetics* 2(4):273-283.

Descriptors: mouse, behaviorally deficient mutant, environmental enrichment, vestibular, muscular, and visual stimulation.

Gue, M., J. Fiorimonte, and L. Bueno (1987). **Comparative influences of acoustic and cold stress on gastrointestinal transit in mice.** *American Journal of Physiology* 253(2 pt.1):G124-G128.

NAL call number: 447.8 Am3

Descriptors: mouse, noise, stress, temperature, gastrointestinal transit.

Hastings, I.M. and W.G. Hill (1993). **The effects of cage type on murine body composition.** *Mouse Genome* 91(2):329-330.

NAL call number: QL737 R638M68

Descriptors: mouse, high fat content, plastic vs. aluminum caging.

Henderson, N.D. (1979). **Dominance for large brains in laboratory mice.** *Behavior Genetics* 9(1):45-49.

NAL call number: QH301 B45

Descriptors: mouse, genetic variance, genotype, housing, environmental enrichment.

Hoffman, G.L., J.R. Simpson, and Y. Arumugam (1991). **Impact of changes in housing condition on mouse natural**

killer cell activity. *Physiology and Behavior* 49(3):657-660.

NAL call number: QP1 P4

Descriptors: mouse, male, caging, tumors, in vitro, cytolytic activity.

Hurst, J.L., F. Jiming, and C.J. Barnard (1993). **The role of substrate odors in maintaining social tolerance between male house mice, *Mus musculus domesticus*.** *Animal Behaviour* 45(5):997-1006.

NAL call number: 410 B77

Descriptors: mouse, male, bedding, olfaction, isolation, interaction.

Iturrian, W.B. (1971). **Effect of noise in the animal house on experimental seizures and growth of weanling mice.** In: *Defining the Laboratory Animal*, pp. 332-352.

NAL call number: SF406 I52

Descriptors: mouse, age, noise, test interval, seizure-prone, drugs, non-auditory stimuli.

Iturrian, W.B. and G.B. Fink (1968). **Comparison of bedding material: Habitat preference of pregnant mice and reproductive performance.** *Laboratory Animal Care* 18(2):160-164.

NAL call number: 410.9 P94

Descriptors: mouse, female, behavior, cellulose, nesting.

Jacobs, B.B. and D.K. Dieter (1978). **Spontaneous hepatomas in mice inbred from HA-ICR Swiss stock: Effects of sex, cedar shavings in bedding, and immunization with fetal liver or hepatoma cells.** *Journal of the National Cancer Institute* 61(6):1531-1534.

NAL call number: 176.622 J82

Descriptors: mouse, SWJ/Jac, male, female, hepatoma, cedar shavings, bedding.

Jones, R.B. (1992). **Reply to McGregor, Barnard, and Hurst** (see *App.Anim.Behav.Sci.* 33:297-299). *Applied Animal Behaviour Science* 33:300-301.

Descriptors: mouse, environmental enrichment, impoverished, aggression, caging, animal welfare.

Jones, R.B. (1992). **Varied cages and aggression.** *Applied Animal Behaviour Science* 33(2-3):295-296.

Descriptors: mouse, male, environmental enrichment, standard caging, impoverished, dominance, submission, fighting, olfaction, benefits.

Karp, J.D., J.A. Moynihan, and R. Ader (1993). **Effects of differential housing on the primary and secondary antibody responses of male C57BL/6 and BALB/c mice.** *Brain, Behavior, and Immunity* 7(4):326-333.

Descriptors: mouse, inbred, male, keyhole limpet hemocyanin, isolation, group-reared, IgM, IgG.

Klipple, J.A. (1978). **Behavioral persistence following switchovers between environmental enrichment and impoverishment in mice.** *Developmental Psychobiology* 11(6):541-557.

NAL call number: QP351 D4

Descriptors: mouse, weanling, environmental enrichment, impoverishment, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(i) Does it really induce aggression?** *Journal of Ethology* 11(2):117-130.

NAL call number: QL750 J68

Descriptors: mouse, isolation, group-reared, dominance, territorial dominance, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(ii) Variance in aggression.** *Journal of Ethology* 11(2):131-140.

NAL call number: QL750 J68

Descriptors: mouse, isolation, dominance, behavior.

Kropveld, D. and R.A. Chamuleau (1993). **Doppler radar device as a useful tool to quantify the liveliness of the experimental animal.** *Medical and Biological Engineering and Computing* 31(4):340-342.

Descriptors: mouse, BALB/c, rat, Wistar, activity, circadian rhythm.

Kubanis, P., S.F. Zornetzer, and G. Freund (1982). **Memory and postsynaptic cholinergic receptors in aging mice.** *Pharmacology, Biochemistry, and Behavior* 17(2):313-322.

NAL call number: QP901 P4

Descriptors: mouse, C57BL/6, male, female, young, old, passive avoidance tasks, ³H-QNB, muscarinic receptor binding, benzodiazepine binding, cortex, striatum, hippocampus, cerebellum, brain stem.

Levine, L., J. Grossfield, and R.F. Rockwell (1979). **Functional relationships between genotypes and environments in behavior: Effects of different kinds of early social experience on interstrain fighting in male mice.** *Journal of Heredity* 70(5):317-320.

NAL call number: 442.8 Am3

Descriptors: mouse, ST/bJ, CBA/J, male, socially reared, isolation, behavior.

Manosevitz, M. and J.B. Pryor (1975). **Cage size as a factor in environmental enrichment.** *Journal of Comparative and Physiological Psychology* 89(6):648-654.

NAL call number: 410 J822

Descriptors: mouse, C57BL/6J, cage size, surface texture, wire, Plexiglas, body weight, open-field, defecation, running-wheel, exploration, water consumption.

Manosevitz, M., R.B. Campenot, and C.F. Swencionis (1968). **Effects of enriched environment upon hoarding.** *Journal of Comparative and Physiological Psychology* 66(2):319-324.

NAL call number: 410 J822

Descriptors: mouse, inbred, genotype, genotype/environment interactions.

Manosevitz, M. and U. Joel (1973). **Behavioral effects of environmental enrichment in randomly bred mice.** *Journal of Comparative and Physiological Psychology* 85(2):373-382.

NAL call number: 410 J822

Descriptors: mouse, open field, defecation, running wheel, exploration, hoarding, activity, adrenal gland, body weight, behavior.

Manosevitz, M. (1970). **Early environmental enrichment and mouse behavior.** *Journal of Comparative and Physiological Psychology* 71(3):459-466.

NAL call number: 410 J822

Descriptors: mouse, open field, running wheel, food competition, defecation.

Manosevitz, M. and R.J. Montemayor (1972). **Interaction of environmental enrichment and genotype.** *Journal of Comparative and Physiological Psychology* 79(1):67-76.

NAL call number: 410 J822

Descriptors: mouse, A/J, C3H/HeJ, C57BL/10J, neonate, weanling, open field, exploration, running wheel, activity.

Martinez, S., M. Ramirez, A. Salvador, and V.M. Simon (1993). **Olfaction of defeated mice may play an important role in subsequent agonistic behavior of the winners.** *Aggressive Behavior* 19(1):60-61.

NAL call number: BF575 A3A57

Descriptors: mouse, male, isolation, socially housed, behavior, exploration, activity, abstract.

McGregor, P.K., C. Barnard, and J.L. Hurst (1992). **Reply [to R.B. Jones on Varied cages and aggression].** *Applied Animal Behaviour Science* 33: 297-299.

NAL call number: QL750 A6

Descriptors: mouse, male, aggression, caging, objects, dominance, submission, fighting, animal welfare, environmental enrichment, anthropocentric view, olfaction.

McGregor, P.K. and S.J. Ayling (1990). **Varied cages result in more aggression in male CFLP mice.** *Applied Animal Behaviour Science* 26(3):277-281.

NAL call number: QL750 A6

Descriptors: mouse, CFLP, male, behavior, caging.

- Misslin, R. and P. Ropartz (1981). **Responses of mice to a novel object.** *Behaviour* 78(3-4):169-177.
NAL call number: 410 B393
Descriptors: mouse, Swiss albino, male, novel environment, familiar environment, contacts, behavior.
- Mondragon, R., L. Mayagoitia, A. Lopez-Lujan, and J.-L. Diaz (1987). **Social structure features in three inbred strains of mice, C57BL/6J, Balb/cj, and NIH: A comparative study.** *Behavioral and Neural Biology* 47(3):384-391.
NAL call number: QH301 C63
Descriptors: mouse, male, adult, inbred, behavior, aggression, exercise wheel.
- Mulder, J.B. (1975). **Bedding preferences of pregnant laboratory reared mice.** *Behavior Research Methods and Instrumentation* 7(1):21-22.
Descriptors: mouse, female, bedding.
- Nielsen, J., O. Andersen, and P. Svendsen (1985). **Induction of liver-enzymes in mice by alpha-pinene from softwood bedding.** *Zeitschrift für Versuchstierkunde* 27((2):105.
NAL call number: 410 Z36
Descriptors: mouse, bedding, spruce/pine shavings, pinene, P-450 enzymes, anesthesia.
- Nielsen, J.B., Andersen, O., and P. Svendsen (1986). **Hepatic O-deethylase activity in mice on different types of bedding.** *Zeitschrift für Versuchstierkunde* 28(1-2):69-75.
NAL call number: 410 Z36
Descriptors: mouse, male, female, wood shavings.
- Petitto, J.M., D.T. Lysle, J.L. Gariepy, and M.H. Lewis (1994). **Association of genetic differences in social behavior and cellular immune responsiveness: Effects of social experience.** *Brain, Behavior, and Immunity* 8(2):111-122.
Descriptors: mouse, ICR, social behavior, isolation-induced aggressiveness, group housing, tumor development, natural killer cells, T cells, B cells.
- Port, C.D. and J.P. Kalenbach (1969). **The effect of corncob bedding on reproductivity and leucine incorporation in mice.** *Laboratory Animal Care* 19(1):46-49.
NAL call number: 410.9 P94
Descriptors: mouse, mycotoxins, dietary proteins, liver metabolism.
- Schrott, L.M., V.H. Denenberg, G.F. Sherman, N.S. Waters, G.D. Rosen, and A.M. Galaburda (1992). **Environmental enrichment, neocortical ectopias, and behavior in the autoimmune NZB mouse.** *Developmental Brain Research* (Netherlands) 67(1):85-93.
Descriptors: mouse, New Zealand Black, male, discrimination learning, spatial maze, shuttlebox, autoimmune disease.
- Smith, W. and S. Ross (1953). **The hoarding behavior of the mouse.** *The Journal of Genetic Psychology* 82: 279-316.
Descriptors: mouse, behavior, feed.
- Tennekes, H.A., A.S. Wright, K.M. Dix, and J.H. Koeman (1981). **Effects of dieldrin, diet, and bedding on enzyme function and tumor incidence in livers of male CF-1 mice.** *Cancer Research* 41(9):3615-3620.
NAL call number: 448.8 C16
Descriptors: mouse, CF-1, male, bedding, Douglas fir sawdust, body weight, organ weight, hepatomas, hepatocellular enzymes.
- Terranova, M.L., G. Laviola, and E. Alleva (1993). **Ontogeny of amicable social behavior in the mouse: gender differences and ongoing isolation outcomes.** *Developmental Psychobiology* 26(8):467-481.
NAL call number: QP351 D4
Descriptors: mouse, outbred CD-1, male, female, weanling, isolation, pair housing, play behavior, social interactions, exploration, activity, affiliative behavior.
- Torronen, R., K. Pelkonen, and S. Karenlampi (1989). **Enzyme-inducing and cytotoxic effects of wood-based**

materials used as bedding for laboratory animals. Comparison by a cell culture study. [published erratum appears in Life Science 1989: 45(24):2381] *Life Science* 45(6):559-565.

NAL call number: 442.8 L62

Descriptors: mouse hepatoma cell line, Hepa-1, hardwoods (aspen and alder), softwoods (pine and pine-spruce), cellulose materials, cytochrome P450I1A, aldehyde dehydrogenase.

van de Weerd, H. A., V. Baumans, J.M. Koolhaas, and L.F.M. van Zutphen (August 1994). **Strain specific behavioural response to environmental enrichment in the mouse.** *Journal of Experimental Animal Science*. 36(4-5):117-127.

Descriptors: behavior, environment design, housing, Inbred BALB C, Inbred C57BL, species specificity.

Vlahakis, G. (1977). **Possible carcinogenic effects of cedar shavings in bedding of C3H-AVY FB mice.** *Journal of the National Cancer Institute* 58(1):149-150.

NAL call number: 176.622 J82

Descriptors: mouse, C3H-AVY, female, bedding, pine shavings, cedar shavings, mammary gland tumors.

Wainwright, P.E., Y.S. Huang, B. Bulman-Fleming, S. Levesque, and D. McCutcheon (1994). **The effects of dietary fatty acid composition combined with environmental enrichment on brain and behavior in mice.** *Behavioural Brain Research* 60(2):125-136.

Descriptors: mouse, male, female, pregnancy, weaning, nutrition, brain composition, Morris water maze, learning.

Wainwright, P.E., S. Levesque, L. Krempulec, B. Bulman-Fleming, and D. McCutcheon (1993). **Effects of environmental enrichment on cortical depth and Morris-maze performance in B6D2F2 mice exposed prenatally to ethanol.** *Neurotoxicology and Teratology* 15(1):11-20.

Descriptors: mouse, cortex, body weight, water maze, learning.

Ward, G.E. and D. DeMille (1991). **Environmental enrichment for laboratory mice (*Mus musculus*).** *Animal Technology: Journal of the Institute of Animal Technology* 42(3):149-156.

NAL call number: QL55 I5

Descriptors: mouse, environmental enrichment, cages, bottles, toys.

Warren, J.M., C. Zerweck, and A. Anthony (1982). **Effects of environmental enrichment on old mice.** *Developmental Psychobiology* 15(1):13-18.

NAL call number: QP351 D4

Descriptors: mouse, C57BL/6J, male, old, behavior, brain chemistry, toys, housing, females, cerebral cortex, maze, tasks.

Wilson, R.A. and P.S. Coulson (1984). **The effect of soft-wood bedding on the maturation of an infection of *Schistosoma mansoni* in mice exposed to cercariae via the tail or abdominal skin.** *Transactions of the Royal Society of Tropical Medicine and Hygiene* 78(3):411-412.

NAL call number: 448.9 R813

Descriptors: mouse, bedding, softwood sawdust, *Schistosoma mansoni*.

Yates, G., J. Panksepp, S. Ikemoto, E. Nelson, and R. Conner (1991). **Social isolation effects on the "behavioral despair" forced swimming test: Effect of age and duration of testing.** *Physiology and Behavior* 49(2):347-353.

NAL call number: QP1 P4

Descriptors: mouse, Swiss Webster, male, female, weanling, young depression, immobility, body weight, reserpine.

Yoshimura, H. and N. Kimura (1993). **Ethopharmacology of behavioral disorders induced by prolonged individual housing in male mice.** *Japanese Journal of Pharmacology* 61(Supplement 1):94.

Descriptors: mouse, male, isolation, copulation, imipramine, chlordiazepoxide, anti-psychotic drugs.

Zahem, H.B. and C.W. Alliston (1974). **The effects of noise level and elevated ambient temperature upon selected reproductive traits in female Swiss Webster mice.** *Laboratory Animal Science* 24(3):469-475.

NAL call number: 410.9 P94

Descriptors: mouse, Swiss Webster, female, temperature, noise, reproduction, embryos, gestation.

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Rats

Ando, S., Y. Ohashi, and S. Kobayashi (1993). **Enhancement of learning ability by enriched environment.** *Neuroscience Research Supplement* 0(18):S150.

Descriptors: rat, environmental enrichment, learning, abstract.

Anzaldo, A.J., P.C. Harrison, G.L. Riskowski, L.A. Sebek, R-G. Maghirang, W.R. Stricklin, and H.W. Gonyou (1994). **Increasing welfare of laboratory rats with the help of spatially enhanced cages.** *Animal Welfare Information Center Newsletter* 5(3):1-2, 5.

NAL call number: aHV4701 A952

Descriptors: rat, Sprague-Dawley, male, caging, platforms, decks, cage dividers, spatially enhanced.

Armario, A., J.M. Castellanos, and J. Balaseh (1985). **Chronic noise stress and insulin secretion in male rats.** *Physiology and Behavior* 34:359-361.

NAL call number: QP1 P4

Descriptors: rat, male, stress, insulin, noise, behavior.

Batchelor, G.R. (1994). **The rest/activity rhythm of the laboratory rat housed under different systems.** *Animal Technology: Journal of the Institute of Animal Technicians* 45(3):181-187.

NAL call number: QL55 I5

Descriptors: rat, Wistar, male, sleep, activity, caging, isolation, socially reared, ladders, climbing frame, funnel, tubes, boxes, nesting container, film canisters, foraging devices.

Batchelor, G.R. (1993). **An enriched commune housing system for laboratory rats: A preliminary view.** *Animal Technology: Journal of the Institute of Animal Technicians* 44(3):201-213.

NAL call number: QL55 I5

Descriptors: rat, rabbit, housing, social groups, behavior, ladders, shelves, tubes, funnels, climbing frame, boxes.

Bean, G. and T. Lee (1991). **Social isolation and cohabitation with haloperidol-treated partners: Effect on density of striatal dopamine D2 receptors in the developing rat brain.** *Psychiatry Research* 36(3):307-317.

Descriptors: rat, male, female, weanling, young, isolation, striatum, handling.

Bennett, E.L., et al. (1974). **Effects of successive environments on brain measures.** *Physiology and Behavior* 12(4):621-631.

NAL call number: QP1 P4

Descriptors: rat, Berkeley S₁, environmental enrichment, impoverished, cerebrum, brain weight, acetylcholinesterase, cholinesterase, interlaboratory comparison.

Bennett, E.L., M.R. Rosenzweig, and M.C. Diamond (1969). **Rat brain: Effects of environmental enrichment on wet and dry weights.** *Science* 163(3869):825-826.

NAL call number: 470 Sci2

Descriptors: rat, Berkeley S₁, male, cortex, brain weight, impoverished.

Bernstein, L. (1972). **The reversibility of learning deficits in early environmentally restricted rats as a function of amount of experience in later life.** *Journal of Psychosomatic Research* 16(1):71-73.

Descriptors: rat, environmental enrichment, isolation, learning.

Bernstein, L. (1973). **A study of some enriching variables in a free-environment for rats.** *Journal of Psychosomatic*

Research 17(2):85-88.

Descriptors: rat, space, visual enrichment, toys, running wheel, activity, learning.

Bernstein, L. (1979). **Hebb's claim of irreversibility in environmentally restricted rats.** *American Psychologist* 34(9):802-803.

Descriptors: rat, learning, problem solving, environmental enrichment.

Bhide, P.G. and K.S. Bedi (1985). **The effects of a 30 day period of environmental diversity on well-fed and previously undernourished rats: Neuronal and synaptic measures in the visual cortex (area 17).** *Journal of Comparative Neurology* 236(1):121-126.

NAL call number: QP351 J68

Descriptors: rat, fetus, neonate, adult, nutrition, visual cortex, histology.

Birke, L.I. and D. Sadler (1988). **Effects of modulating neonatal progestins and androgens on the development of play and other social behavior in the rat.** *Hormones and Behavior* 22(2):160-171.

NAL call number: QP801 H7H64

Descriptors: rat, male, female, testosterone anti-serum, progestin anti-serum, medroxyprogesterone.

Black, J.E., M. Polinsky, and W.T. Greenough (1989). **Progressive failure of cerebral angiogenesis supporting neural plasticity in aging rats.** *Neurobiology of Aging* (USA) 10(4):353-358.

Descriptors: rat, old, capillaries, synaptogenesis, visual cortex, toys.

Bokovin, A.G. and E.S. Petrov (1992). **Influence of perceptual experience on the agonistic behavior of rats bred in isolation.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 42(4):800-802.

Descriptors: rat, male, neonate, adult, behavior, social interactions.

Borg, E. and A.R. Moller (1978). **Noise and blood pressure: Effect of lifelong exposure in the rat.** *Acta Physiologica Scandinavica* 103: 340-342.

NAL call number: QP1 A2

Descriptors: rat, Sprague-Dawley, Wistar, Lancing horns, long term study.

Bowling, S.L., J.K. Rowlett, and M.T. Bardo (1993). **The effect of environmental enrichment on amphetamine-stimulated locomotor activity, dopamine synthesis, and dopamine release.** *Neuropharmacology* 32(9):885-893.

NAL call number: RM315 N4

Descriptors: rat, male, environmental enrichment, impoverished, nucleus accumbens, striatum, *in vivo*, *in vitro*.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology: Journal of the Institute of Animal Technology* 43(2):99-105.

NAL call number: QL55 I5

Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Brenner, E., M. Mirmiran, H.B.M. Uylings, and J. Van Der Gugten (1985). **Growth and plasticity of cerebral cortex after central noradrenaline depletion.** *Experimental Neurology* 89(1):264-268.

NAL call number: RC231 E96

Descriptors: rat, Wistar, bilateral ICV injection, 6-hydroxydopamine, brain growth.

Buelke-Sam, J., P.A. Sullivan, C.A. Kimmel, and C.J. Nelson (1984). **Sex and strain differences in the developmental activity profile of the rat tested over clean vs. home cage bedding.** *Developmental Psychobiology* 17(1):67-77.

NAL call number: QP351 D4

Descriptors: rat, CD, Long-Evans, male, female, neonate, olfaction, behavior, hyperactivity.

Burgess, M.L., J.M. Davis, T.K. Borg, S.P. Wilson, W.A. Burgess, and J. Buggy (1993). **Exercise training alters cardiovascular and hormonal responses to intracranial self-stimulation.** *Journal of Applied Physiology* 75(2):863-869.

NAL call number: 447.8 J825

Descriptors: rat, male, endocrine system, treadmill, ventral tegmental area, lever pressing, adrenal, organ weights, body weight.

Burkhart, C.A. and J.L. Robinson (1978). **High rat pup mortality attributed to use of cedar wood shavings as bedding.** *Laboratory Animals* 12(4):221-222.

NAL call number: QL55 A1L3

Descriptors: rat, Sprague-Dawley, male, female, adult, neonate, bedding, corncocks, aspen shavings, cedar shavings, mortality.

Camel, J.E., G.S. Withers, and W.T. Greenough (1986). **Persistence of visual cortex dendritic alterations induced by postweaning exposure to a "superenriched" environment in rats.** *Behavioral Neuroscience* 100(6):810-813.

NAL call number: QP351 B45

Descriptors: rat, postweaning, toys, maze, barriers, occipital cortex, neuronal development.

Carughi, A., K.J. Carpenter, and M.C. Diamond (1989). **Effect of environmental enrichment during nutritional rehabilitation on body growth, blood parameters, and cerebral cortical development of rats.** *Journal of Nutrition* (USA) 119(12):2005-2016.

NAL call number: 389.8 J82

Descriptors: rat, male, neonate, malnutrition, dendrites, occipital cortex, toys.

Caul, W.F., B.J. Freeman, and D.C. Buchanan (1975). **Effects of differential rearing condition on heart rate conditioning and response suppression.** *Developmental Psychobiology* 8(1):63-68.

NAL call number: QP351 D4

Descriptors: rat, Sprague-Dawley, male, female, weanling, environmental enrichment, isolation.

Chaloupka, Z., J. Myslivecek, B. Semiginovsky, and J. Hassmannova (1971). **The effect of afferentation in early postnatal life on the formation of temporary connections and other properties of the brain.** *Activitas Nervosa Superior* 13(2):147-148.

Descriptors: rat, environmental enrichment, impoverished, neural activity.

Chao, H.M., D.C. Blanchard, R.J. Blanchard, B.S. McEwen, and R.R. Sakai (1993). **The effect of social stress on hippocampal gene expression.** *Molecular and Cellular Neurosciences* 4(6):543-548.

Descriptors: rat, male, female, visible burrows, dominance, interactions, behavior, neuroendocrine effects, corticosterone, glucocorticoid receptor, mineralocorticoid receptor, mRNA, growth-associated protein, preproenkephalin.

Chia-Hung, H., W. Ching-Hsien, J. Tz-Yi, and W.C. Su-Yu, (1976). **The effects of learning and environment on the rat's brain.** *Acta Psychologica Taiwanica* 18:25-30.

Descriptors: rat, cortex, environmental enrichment, learning, Hebb-Williams maze, methamphetamine, brain weight, activity.

Coburn, J.F. and R.D. Tarte (1976). **The effect of rearing environments on the contrafreeloading phenomenon in rats.** *Journal of the Experimental Analysis of Behavior* 26(2):289-294.

Descriptors: rat, Wistar, male, female, environmental enrichment, impoverishment, operant chambers, feed acquisition.

Cowie, S., S. Quintero, and N. McNaughton (1987). **Home cage and test apparatus artifacts in assessing behavioural effects of diazepam in rats.** *Psychopharmacology* 91(2):257-259.

Descriptors: rat, partial reinforcement, extinction effect, sodium amylobarbitone, chlordiazepoxide, anxiolytics.

Coyle, I.R. and G. Singer (1975). **The interactive effects of prenatal imipramine exposure and postnatal rearing conditions on behaviour and histology.** *Psychopharmacologia* 44(3):253-256.

Descriptors: rat, Wistar, male, female, weanling, imipramine, environmental enrichment, impoverished, brain histology, behavior.

Coyle, I.R. and G. Singer (1975). **The interaction of postweaning housing conditions and prenatal drug effects on**

behaviour. *Psychopharmacologia* 41(3):237-244.

Descriptors: rat, Wistar, male, female, weanling, imipramine, Vitamin A, environmental enrichment, impoverished, Henderson-type maze, swimming maze.

Crepeau, L.J. (1990). **The interactive influences of early handling, prior play exposure, acute stress, and sex on play behavior, exploration, and H-P-A reactivity in juvenile rats.** *Dissertation Abstracts International* 51(3-B):1133.

NAL call number: Z5055.U49D53

Descriptors: rat, adrenal glands, hypothalamo-pituitary-adrenal axis.

Crnic, L. (1983). **Effects of nutrition and environment on brain biochemistry and behavior.** *Developmental Psychobiology* 16(2):129-145.

NAL call number: QP351 D4

Descriptors: rat, Sprague-Dawley, female, malnutrition, environmental enrichment, behavior, open field, passive-avoidance performance.

Crnic, L.S. (1984). **Nutrition and mental development.** *American Journal of Mental Deficiency* 88(5):526-533.

Descriptors: rat, environmental enrichment, isolation, malnutrition, behavior, biochemical deficits.

Cummins, R.A., et al. (1973). **Environmentally-induced changes in the brains of elderly rats.** *Nature* 243(5409):516-518.

NAL call number: 472 N21

Descriptors: rat, Wistar, male, female, weanling, old, environmental enrichment, isolation, toys, maze, brain weight, behavior, plasticity.

Cummins, R.A., P.J. Livesey, and J.G. Evans (1977). **A developmental theory of environmental enrichment.** *Science* 197(4304):692-694.

NAL call number: 470 Sci2

Descriptors: rat, male, brain development, environmental enrichment, deprivation.

Dalrymple-Alford, J.C. and C.R. Kelche (1987). **Behavioral effects of differential postoperative housing after septal lesions made in weanling rats.** *Psychobiology* 15(3):255-260.

Descriptors: rat, male, weanling, behavior, open field, radial maze.

Dalrymple-Alford, J., C. Kelche, F. Eclancher, and B. Will (1988). **Preoperative enrichment and behavioral recovery in rats with septal lesions.** *Behavioral and Neural Biology* 49(3):361-373.

NAL call number: QH301 C63

Descriptors: rat, male, weaning, adult, behavior, open field, radial maze.

Davis, S.F. et al. (1975). **Contrafreeloading as a function of early environmental rearing conditions.** *Bulletin of the Psychonomic Society* 6(6):595-597.

Descriptors: rat, Holtzman, male, environmental enrichment, impoverished, feed acquisition, learning.

DeBlieux, P.M.C. (1993). **Exercise training improves cardiac performance in diabetic rats.** *Proceedings of the Society for Experimental Biology and Medicine* 203(2):209-213.

NAL call number: 442.9 S1

Descriptors: rat, female, cardiomyopathy, streptozotocin, diabetes mellitus, treadmill.

Dell, P.A. and F.D. Rose (1986). **The impairing effects of environmental impoverishment in rats: A cognitive deficit?** *IRCS Medical Science: Psychology and Psychiatry* 14(1-2):19-20.

Descriptors: rat, Hooded Lister, male, Hebb-Williams maze, learning activity, exploratory behavior.

Dell, P.A., and F.D. Rose (1987). **The role of environmentally induced brain changes in subserving behavioural function: An investigation in female rats postpartum.** *Medical Science Research* 15(16):959-960.

Descriptors: rat, female, virgin, pregnant, cortical depth, enrichment.

- Dell, P.A. and F.D. Rose (1987). **Transfer of effects from environmentally enriched and impoverished female rats to future offspring.** *Physiology and Behavior* 39(2):187-190.
NAL call number: QP1 P4
Descriptors: rat, female, behavior, pre-pregnancy, pregnancy.
- Deni, R., et al. (1982). **Effect of cross-litter pup and cage bedding changes on huddling in rat pups.** *Psychological Record* 32(4):543-549.
Descriptors: rat, Norway, male, female, neonate, contact behavior, ultrasonic vocalizations, olfaction.
- Devenport, L., S. Dallas, C. Carpenter, and M.J. Renner (1992). **The relationship between adrenal steroids and enrichment-induced brain growth.** *Behavioral and Neural Biology (USA)* 58(1):45-50.
NAL call number: QH301 C63
Descriptors: rat, male, brain weight, adrenalectomy, corticosterone.
- Diamond, M.C., R.E. Johnson, A.M. Protti, et al. (1985). **Plasticity in the 904-day-old male rat cerebral cortex.** *Experimental Neurology* 87(2):307-317.
NAL call number: RC321 E96
Descriptors: rat, Long-Evans, male, toys, frontal cortex, parietal cortex, occipital cortex, histology.
- Diamond, M.C., et al. (1977). **Effects of aging and environment on the pyriform cortex, the occipital cortex and the hippocampus.** *Behavioral and Neural Biology* 20(3):325-336.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, neonates, old, brain thickness, brain development, memory.
- Diamond, M.C., E.R. Greer, A. York, et al. (1987). **Rat cortical morphology following crowded-enriched conditions.** *Experimental Neurology* 96(2):241-247.
NAL call number: RC321 E96
Descriptors: rat, male, medial occipital cortex, toys, caging.
- Domjan, M., R. Schorr, and M. Best (1977). **Early environmental influences on conditioned and unconditioned ingestional and locomotor activity.** *Developmental Psychobiology* 10(6):499-506.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, post-weaning, socialization, isolation, handling, aversive stimuli, taste aversion, open field, gustatory-visceral sensory system, telereceptor-cutaneous sensory system.
- Doty, B.A. (1972). **The effects of cage environment upon avoidance responding of aged rats.** *Journal of Gerontology* 27(3):358-360.
NAL call number: 447.8 J824
Descriptors: rat, Sprague-Dawley, old, environmental enrichment, impoverished, learning.
- Ducommun, D. (1993). **Humane care of laboratory rats.** *AWI Quarterly (Animal Welfare Institute)* 42(4):14.
NAL call number: HV4761 A5
Descriptors: rat, social groups, behavior, caging, handling, identification, exercise, gnawing, running wheel, toys, nest building, psychology experiments.
- Dunnett, S.B., I.Q. Whishaw, S.T. Burch, and A. Fine (1986). **Acetylcholine-rich neuronal grafts in the forebrain of rats: Effects of environmental enrichment, neonatal noradrenaline depletion, host transplantation site and regional source of embryonic donor cells on graft size and acetylcholinesterase-positive fibre outgrowth.** *Brain Research* 378(2):357-373.
NAL call number: Film S-1779
Descriptors: rat, Sprague-Dawley, male, neocortex, nucleus basalis lesions, hippocampus, fimbria-fornix lesions.
- Dwoskin, L.P., A.L. Jewell, S.T. Buxton, M. Bradley, and M.T. Bardo (1993). **Environmental enrichment decreases the sensitivity of dopamine autoreceptors in rat nucleus accumbens.** *Society for Neuroscience Abstracts* 19(1-

3):822 .

NAL call number: QP351 S6

Descriptors: rat, environmental enrichment, amphetamine, striatum.

Edward, H.P., W.F. Barry, and J.O. Wyspianski (1968). **Early environment effects on rat photic evoked potentials: A preliminary study.** *Revista Interamericana de Psicología* 2(2):85-92.

Descriptors: rat, Sprague-Dawley, male, environmental enrichment, cortical potentials.

Einon, D. and M. Potegal (1991). **Enhanced defense in adult rats deprived of playfighting experience as juveniles.** *Aggressive Behavior* 17(1):27-40.

NAL call number: BF575 A3A57

Descriptors: rat, male, isolation, pairs, defense, tonic immobility, social threat.

Einon, D.F., M.J. Morgan, and B.E. Will (1980). **Effects of post-operative environment on recovery from dorsal hippocampal lesions in young rats: Tests of spatial memory and motor transfer.** *Quarterly Journal of Experimental Psychology* 32(1):137-148.

Descriptors: rat, Long-Evans, male, young, hippocampal lesions, learning, memory tasks, motor tasks.

Escorihuela, R.M., A. Tobena, and A. Fernandez-Teruel (1994). **Environmental enrichment reverses the detrimental action of early inconsistent stimulation and increases the beneficial effects of postnatal handling on shuttlebox learning in adult rats.** *Behavioural Brain Research* 61(2):169-173.

Descriptors: rat, Sprague-Dawley, neonate, adult, postnatal handling, active avoidance task, learning.

Faith, R.E., S.J. Henning, D.R. McCarty and W.F. McKenzie (1985). **Reduction of reproductive efficiency in Sprague-Dawley rats by softwood bedding.** *Laboratory Animal Science* 35(5):555.

NAL call number: 410.9 P94

Descriptors: rat, Sprague-Dawley, abstract.

Falkenberg, T., A.K. Mohamed, B. Henriksson, H. Persson, B. Winblad, and N. Lindfors (1992). **Increased expression of brain-derived neurotrophic factor mRNA in rat hippocampus is associated with improved spatial memory and enriched environment.** *Neuroscience Letters* (Ireland) 138(1):153-156.

NAL call number: QP351 N3

Descriptors: rat, water maze, learning, memory, brain-derived neurotrophic factor.

Ferchmin, P.A., V.A. Eterovic, and L.E. Levin (1980). **Genetic learning deficiency does not hinder environment-dependent brain growth.** *Physiology and Behavior* 24(1):45-50.

NAL call number: QP1 P4

Descriptors: rat, shuttlebox avoidance, exploratory behavior, Greek Cross apparatus, brain weight.

Ferchmin, P.A., E.L. Bennett, and M.R. Rosenzweig (1975). **Direct contact with enriched environment is required to alter cerebral weight in rats.** *Journal of Comparative and Physiological Psychology* 88(1):360-367.

NAL call number: 410 J822

Descriptors: rat, Berkeley S₁, interaction with environment, environmental enrichment, isolation, impoverished, brain weight, behavior.

Ferchmin, P.A. and V.A. Eterovic (1990). **Experience affects cortical but not subcortical polyamines.** *Pharmacology, Biochemistry, and Behavior* (USA) 35(1):255-258.

NAL call number: QP901 P4

Descriptors: rat, occipital cortex, cortex, subcortex, cerebellum, DFMO, spermidine, spermine, putrescine.

Fernandez, V., R. Pascual, and S. Ruiz (1993). **Early-life environmental deterioration, nutrition, and ontogeny of the motor cortex in the rat - A Golgi study.** *Biology of the Neonate* 64(4):245-253.

NAL call number: QH301 B46

Descriptors: rat, Sprague-Dawley, impoverished housing, diet, cortex, neurons, body weight, size, motor pyramids, dendrites.

- Fessler, R.G. and W.W. Beatty (1976). **Variations in postweaning environment and sensitivity to electric shock in male and female rats.** *Behavioral Biology* 16(4):535-538.
NAL call number: QH301 C63
Descriptors: rat, Holtzman-derived, male, female, environmental enrichment, isolation, shock thresholds, open field, behavior.
- Fiala, B., F.M. Snow, and W.T. Greenough (1977). **"Impoverished" rats weigh more than "enriched" rats because they eat more.** *Developmental Psychobiology* 10(6):537-541.
NAL call number: QP351 D4
Descriptors: rat, Long-Evans, male, female, weanling, toys, isolation, socialization, boredom, body weight, feed consumption, water consumption.
- Fordyce, D.J. and J.F. Knutson (1980). **Influence of blinding and home-cage lighting on aggressive behaviors of laboratory rats.** *Physiology and Behavior* 25:217-226.
NAL call number: QP1 P4
Descriptors: rat, hooded, male, blinding, home-cage aggression, shock-induced aggression, lighting.
- Fowler, S.C., J.S. Johnson, M.J. Kallman, Jr. Liou, et al. (1993). **In a drug discrimination procedure isolation-reared rats generalize to lower doses of cocaine and amphetamine than rats reared in an enriched environment.** *Psychopharmacology* 110(1-2):115-118.
Descriptors: rat, male, environmental enrichment, isolation, operant procedure, dopaminergic agonists, learning.
- Galef, B.J. Jr. and P. Durlach (1993). **Should large rats be housed in large cages? An empirical issue.** *Canadian Psychology* 34(2):203-207.
Descriptors: rat, preference test, cage size, behavior, Canadian Council on Animal Care.
- Garcia-Brull, P.D., J. Nunez, and A. Nunez (1993). **The effect of scents on the territorial and aggressive behaviour of laboratory rats.** *Behavioural Processes* 29(1-2):25-36.
NAL call number: QL750 B4
Descriptors: rat, Wistar, male, female, young, adult, odors, dominance, behavior, urine, alpha male.
- Gardner, E.B. et al. (1975). **Environmental enrichment and deprivation: Effects on learning, memory, and exploration.** *Physiology and Behavior* 14(3):321-327.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, perceptually enriched, socially enriched, impoverished, open field, learning, avoidance training, electric shock.
- Geber, W.T., J.A. Anderson, and B. Van Dyne (1966). **Physiologic responses of the albino rat to chronic noise stress.** *Archives of Environmental Health* 12:751-754.
NAL call number: RC963 A1A7
Descriptors: rat, Sprague-Dawley, adrenal ascorbic acid, auditory stress, brain, eosinophils.
- Gentile, A.M., Z. Beheshti, and J.M. Held (1987). **Enrichment versus exercise effects on motor impairments following cortical removals in rats.** *Behavioral and Neural Biology* 47(3):321-332.
NAL call number: QH301 C63
Descriptors: rat, male, CD, sensorimotor cortex, exercise wheel, environmental enrichment.
- Gentsch, C., M. Lichtsteiner, and H. Feer (1981). **Taste neophobia in individually and socially reared male rats.** *Physiology and Behavior* 27(2):199-202.
NAL call number: QP1 P4
Descriptors: rat, male, isolation, socially reared, hyperactivity, fear, taste neophobia.
- Gentsch, C., M. Lichtsteiner, K. Kraeuchi, and H. Feer (1982). **Different reaction patterns in individually and socially reared rats during exposure to novel environments.** *Behavioural Brain Research* 4:45-54.

Descriptors: rat, isolation, socially reared, behavior, housing.

Gogia, P.P., M. Brown, and S. Al-Obaidi (1993). **Hydrocortisone and exercise effects on articular cartilage in rats.** *Archives of Physical Medicine and Rehabilitation* 74(5):463-467.

Descriptors: rat, Sprague-Dawley, female, treadmill, knees, femoral cartilage, degeneration, fibrosis.

Goldman, H., R.F. Berman, S. Gershon, S.L. Murphy, et al. (1987). **Correlation of behavioral and cerebrovascular functions in the aging rat.** *Neurobiology of Aging* 8(5):409-416.

Descriptors: rat, cerebral blood flow, T-maze, environmental enrichment.

Gonzalez, B. B. Castellano, J.M. Vela, P. Fabregas, I. Dalmau, R.M. Escoriheula, A. Tobena, and A. Fernandez-Teruel (1994). **Infantile stimulation may protect against age-related deficits in RHA-Verh and RLA-Verh rats: A behavioral and histological study.** *Behavior Genetics* 24 (6):514-515(abstract).

Descriptors: brain, postnatal handling, environmental enrichment, learning, cognition.

Greenough, W.T., T.C. Madden, and T.B. Fleischmann (1972). **Effects of isolation, daily handling, and enriched rearing on maze learning.** *Psychonomic Science* 27(5):279-280.

Descriptors: rat, Long-Evans, male, activity, Lashley III maze, straight alley.

Greer, E.R., M.C. Diamond, and J.M. Tang (1982). **Environmental enrichment in Brattleboro rats: Brain morphology.** *Annals of the New York Academy of Sciences* 394:749-752.

NAL call number: 500 N484

Descriptors: rat, Brattleboro, male, heterozygous, homozygous, diabetes insipidus, neocortex, telencephalon, diencephalon, hippocampus, brain size, age.

Greer, E.R. (1982). **Environmental enrichment in rats with a memory deficit (Brattleboro strain).** *Dissertation Abstracts International* 42(7-B):2646-2647.

NAL call number: Film S-1805

Descriptors: rat, Brattleboro, brain morphology.

Gruendel, A.D. (1972). **The influence of experimental factors on the early development and sexual behavior of male rats.** *Dissertation Abstracts International* 33(4-B):1817-1818.

NAL call number: Z5055.U49D53

Descriptors: rat, male, female, environmental enrichment, isolation, impoverished, foster mothers, play.

NAL call number: QP84 M4

Descriptors: rat, Long-Evans, female, young, old, running wheels, aging, citrate synthase, hexokinase, heart, epitrochlearis, flexor digitorum brevis.

Hagemeyer, J.A. and J. Panksepp (1988). **An attempt to evaluate the role of hearing in the social play of juvenile rats.** *Bulletin of the Psychonomic Society* 26(5):455-458.

Descriptors: rat, young, deafness, aminooxyacetic acid, kanamycin, acoustic startle.

Hamilton, W.L., M.C. Diamond, R.E. Johnson, and C.A. Ingham (1977). **Effects of pregnancy and differential environments on rat cerebral cortical depth.** *Behavioral and Neural Biology* 19(3):333-340.

NAL call number: QH301 C63

Descriptors: rat, Long-Evans, female, pregnant, nonpregnant, brain thickness, environmental enrichment, sex, hormonal state.

Hannigan, J.H., R.F. Berman, and C.S. Zajac (1993). **Environmental enrichment and the behavioral effects of prenatal exposure to alcohol in rats.** *Neurotoxicology and Teratology* 15(4):261-266.

Descriptors: rat, postweaning, isolation, groups, ataxia, Morris maze, postnatal environmental enrichment.

Harro, J. (1993). **Measurement of exploratory behavior in rodents.** In: *Methods in Neurosciences, Vol.14. Paradigms for the study of behavior* P.M. Conn, ed., Academic Press, Inc.: San Diego, CA, pp. 359-377.

NAL call number: QP351 M47

Descriptors: rat, male, female, housing, hormones, exploration.

Hart, L.A. (1994). **Opportunities for environmental enrichment in the laboratory.** *Lab Animal* 23(2):24-27.

NAL call number: QL55 A1L33

Descriptors: rats, rabbits, reptiles, zoo animals, farm animals, noise, housing, caging, burrows, nesting materials, social groups.

Held, J.M., J. Gordon, and A.M. Gentile (1985). **Environmental influences on locomotor recovery following cortical lesions in rats.** *Behavioral Neuroscience* 99(4):678-690.

NAL call number: QP351 B45

Descriptors: rat, sensorimotor cortex, locomotor tasks.

Hill, S.Y. and B.J. Powell (1976). **Cocaine and morphine self-administration: Effects of differential rearing.** *Pharmacology, Biochemistry, and Behavior* 5(6):701-704.

NAL call number: QP901 P4

Descriptors: rat, Wistar, post-weaning, environmental enrichment, impoverishment, choice test, morphine, cocaine, emotionality, conditionability, body weight.

Hole, G. (1991). **Proximity measures of social play in the laboratory rat.** *Developmental Psychobiology* 24(2):117-133.

NAL call number: QP351 D4

Descriptors: rat, male, female, littermates, spatial relationships, access to resources, territorial, cover.

Hole, G. (1991). **The effects of social deprivation on levels of social play in the laboratory rat--*Rattus norvegicus*.** *Behavioural Processes* 25(1):41-53.

NAL call number: QL750 B4

Descriptors: rat, male, weanling, isolation, social contact, rough-and-tumble play.

Hole, G. (1988). **Temporal features of social play in the laboratory rat.** *Ethology (formerly Zeitschrift für Tierpsychologie)* 78(1):1-20.

NAL call number: QL750 E74

Descriptors: rat, male, female, young, rough-and-tumble play, duration.

Holson, R.R. (1986). **Feeding Neophobia: A possible explanation for the differential maze performance of rats reared in enriched or isolated environments.** *Physiology and Behavior* 38(2):191-201.

NAL call number: QP1 P4

Descriptors: rat, Long-Evans, male, open field, emergence test, maze, handling.

Holson, R.R., A.C. Scallet, S.F. Ali, and B.B. Turner (1991). **"Isolation stress" revisited: Isolation-rearing effects depend on animal care methods.** *Physiology and Behavior* 49(6):1107-1118.

NAL call number: QP1 P4

Descriptors: rat, male, female, caging, handling, behavior, adrenocortical system, olfaction, open field.

Huck, U.W. and E.O. Price (1975). **Differential effects of environmental enrichment on the open field behavior of wild and domestic Norway rats.** *Journal of Comparative and Physiological Psychology* 89(8):892-898.

NAL call number: 410 J822

Descriptors: rat, Norway, wild, domestic, environmental enrichment, open field, behavior, body, weight, genetic influences.

Ikemoto, S. and J. Panksepp (1992). **The effects of early social isolation on the motivation for social play in juvenile rats.** *Developmental Psychobiology* 25(4):261-274.

NAL call number: QP351 D4

Descriptors: rat, weanling, family reared, peer, isolation, play, t-maze, rewards.

Ina, Y., K. Machida, K. Suzuki, and K. Tsukamoto (1994). **Effects of voluntary wheel running on health indexes in rats with SRBC-induced inflammation.** *Nippon Eiseigaku Zasshi (Japan)* 48(6):1077-1089.

Descriptors: rat, Fischer, male, sheep red blood cells, inflammation, voluntary exercise, feed intake, activity, body weight, blood chemistry, liver function.

Ivinskis, A. and J. Homewood (1980). **Effect of preweaning environmental enrichment on later problem-solving behavior in rats.** *Animal Learning and Behavior* 8(2):336-340.

NAL call number: QL785 A725

Descriptors: rat, female, neonates, handling, Hebb-Williams maze, vision.

Johansson, B.B. and A.-L. Ohlsson (1994). **An enriched environment enhances functional outcome in focal brain ischemia in the rat.** *Stroke* 25(1):265 (abstract).

Descriptors: rat, plasticity, cerebral artery.

Jones, D.G. and B.J. Smith (1980). **Morphological analysis of the hippocampus following differential rearing in environments of varying social and physical complexity.** *Behavioral and Neural Biology* 30(2):135-147.

NAL call number: QH301 C63

Descriptors: rat, Wistar, hippocampus, cortex, cell physiology, preweaning, postweaning, toys, multifamily groups, isolation.

Jones, G.H., C.A. Marsden, and T.W. Robbins (1991). **Behavioural rigidity and rule-learning deficits following isolation-rearing in the rat: neurochemical correlates.** *Behavioural Brain Research* 43(1):35-50.

Descriptors: rat, female, isolation, socialization, visual discrimination, learning, appetitive behavior, cerebral cortex, dopamine.

Joseph, R. and R.E. Gallagher (1980). **Gender and early environmental influences on activity, overresponsiveness, and exploration.** *Developmental Psychobiology* 13(5):527-544.

NAL call number: QP351 D4

Descriptors: rat, male, female, adult, environmental enrichment, running wheel, open field, maze, noxious stimuli.

Julin, C.M. and D.P. Thomas (1993). **Effects of age and exercise training on size and composition of the rat left main coronary artery.** *Journal of Gerontology* 48(3):B101-B107.

NAL call number: 447.8 J824

Descriptors: rat, Fischer 344, female, young, old, sedentary, treadmill, body weight, wall thickness, collagen, elastin.

Katz, H.B. and C.A. Davies (1982). **The effects of early under-nutrition and subsequent environment on morphological parameters of the rat brain.** *Behavioural Brain Research* 5(1):53-64.

Descriptors: rat, hooded Lister, male, undernourishment, brain growth spurt, forebrain, cortex, hippocampus, brain development.

Kazmaier, K., R.E. Butler, R.J. Senter, and R.M. Stutz (1973). **Rearing conditions and ethanol consumption by rats.** *Quarterly Journal of Studies on Alcohol* 34(2):520-524.

Descriptors: rat, Sprague-Dawley, male, emotionality, environmental enrichment, impoverished, handling, bedding, open field, activity.

Kelche, C., J.C. Dalrymple-Alford, and B. Will (1988). **Housing conditions modulate the effects of intracerebral grafts in rats with brain lesions.** *Behavioural Brain Research* 28(3):287-295.

Descriptors: rat, female, behavior, memory, fimbria-fornix, fetal grafts, Hebb-Williams maze, acetylcholinesterase.

Kelche, C., J.C. Dalrymple-Alford, and B. Will (1987). **Effects of postoperative environment on recovery of function after fimbria-fornix transection in the rat.** *Physiology and Behavior* 40(6):731-736.

NAL call number: QP1 P4

Descriptors: rat, female, housing conditions, memory, radial maze.

Kelche, C. and B. Will (1982). **Effects of post-operative environments following dorsal hippocampal lesions on**

dendritic branching and spines in rat occipital cortex. *Brain Research* 245(1):107-115.

NAL call number: Film S-1779

Descriptors: rat, Long-Evans, male, bilateral hippocampal lesions, pyramidal cells, morphology, behavior.

Kelche, C. and B.E. Will (1978). **Effects of environment on functional recovery after hippocampal lesions in adult rats.** *Physiology and Behavior* 21(6):935-941.

NAL call number: QP1 P4

Descriptors: rat, August, male, learning, bilateral lesions, hippocampus, Hebb-Williams maze.

Kemble, E.D. and V.A. Davies (1981). **Effects of prior environmental enrichment and amygdaloid lesions on consummatory behavior, activity, predation, and shuttlebox avoidance in male and female rats.** *Physiological Psychology* 9(4):340-346.

Descriptors: rat, Holtzman, male, female, water consumption, food consumption, activity levels, open field, avoidance test, sex differences.

Kirby, R.J. (1970). **Early environmental experience and avoidance learning in the rat.** *Psychonomic Science* 19(1):30-31.

Descriptors: rat, Sprague-Dawley, weanling, environmental enrichment, impoverished, passive-avoidance problem, emotions.

Kirby, R.J. and J.E. Kirby (1968). **Note: Early environmental experience and spontaneous alternation.** *Psychological Reports* 23(3, Pt.2):1278.

Descriptors: rat, environmental enrichment, impoverished, exploration, learning.

Kiyono, S., M.L. Seo, M. Shibagaki, and M. Inouye (1985). **Facilitative effects of maternal environmental enrichment on maze learning in rat offspring.** *Physiology and Behavior* 34(3):431-435.

NAL call number: QP1 P4

Descriptors: rat, female, pregnant, foster mothers, male offspring, Hebb-Williams maze, postnatal learning.

Klein, S.L., K.G. Lambert, D. Durr, T. Schaefer, and R.E. Waring (1994). **Influence of environmental enrichment and sex on predator stress response in rats.** *Physiology and Behavior* 56(2):291-297.

NAL call number: QP1 P4

Descriptors: rat, male, female, cat avoidance apparatus, stress, stomach, adrenal glands, thymus, defensive behavior.

Klinger, H.J. and E.D. Kemble (1985). **Effects of housing space and litter size on play behavior in rats.** *Bulletin of the Psychonomic Society* 23(1):75-77.

Descriptors: rat, Holtzman, male, female, neonate, caging, play, stress.

Klir, P., R. Bondy, J. Lachout, and T. Hanis (1984). **Physiological changes in laboratory rats caused by different housing.** *Physiologia Bohemoslavaca* 33:111-121.

Descriptors: rat, caging, physiology.

Kramer, K., H. Dijkstra, and A. Bast (1993). **Control of physical exercise of rats in a swimming basin.** *Physiology and Behavior* 53(2):271-276.

NAL call number: QP1 P4

Descriptors: rat, Wistar, male, swimming, exercise, superoxide dismutase, glutathione, diethyl maleate, emotions, maze, norepinephrine, epinephrine, lactate, stress.

Kuenzle, C.C. and A. Knusel (1974). **Mass training of rats in superenriched environment.** *Physiology and Behavior* 13(2):205-210.

NAL call number: QP1 P4

Descriptors: rat, male, apparatus, learning, maze, feed acquisition, water acquisition, behavior.

Larue-Achagiotis, C., C. Martin, P. Verger, M. Chabert, and J. Louis-Sylvestre (1993). **Effects of acute treadmill exercise and delayed access to food on food selection in rats.** *Physiology and Behavior* 53(2):403-408.

NAL call number: QP1 P4

Descriptors: rat, Wistar, male, total energy intake, nutrient self-selection, body weight, carbohydrates, protein, fat.

Latane, B. and D.C. Glass (1969). **Social and nonsocial attraction in rats.** *Journal of Personality and Social Psychology* 9(2, Pt. 1):142-146.

Descriptors: rat, Carworth, fear, open field, defecation, anesthetized rat, toy car, pair interaction, gregariousness.

Leah, J., H. Allardyce, and R. Cummins (1985). **Evoked cortical potential correlates of rearing environment in rats.** *Biological Psychology* 20(1):21-29.

NAL call number: QP351 B52

Descriptors: rat, Wistar, male, enriched environment, isolation.

LeFevre, J. and M.K. McClintock (1991). **Isolation accelerates reproductive senescence and alters its predictors in female rats.** *Hormones and Behavior* 25(2):258-272.

Descriptors: rat, Sprague-Dawley, female, aging, constant estrus, isolation, group rearing, lordosis reflex, ovarian steroids.

Liljequist, R., B.G. Henriksson, N. Latif, T. Pham, B. Winblad, and A.H. Mohammed (1993). **Subchronic MK-801 treatment to juvenile rats attenuates environmental enrichment effects on adult spatial learning.** *Behavioural Brain Research* 56(1):107-114.

Descriptors: rat, environmental enrichment, impoverished, NMDA receptor, open field, [³H]MK-801 binding sites, cortex, learning, activity, cognitive changes.

Lore, R.K. (1969). **Pain avoidance behavior of rats reared in restricted and enriched environments.** *Developmental Psychology* 1(5):482-484.

NAL call number: BF712 D46

Descriptors: rat, Long-Evans, environmental enrichment, impoverished, candle, nose-flame contacts, emotions, perceptual deficits.

Louie, D.S. (1983). **The effects of an enriched environment on the consequences of lactational undernutrition on learning and on brain chemistry in rats.** *Dissertation Abstracts International* 44(1-B):117-118.

NAL call number: Z5055.U49D5

Descriptors: rat, undernutrition, learning, biochemistry.

Luciano, D. and R. Lore (1975). **Aggression and social experience in domesticated rats.** *Journal of Comparative and Physiological Psychology* 88(2):917-923.

NAL call number: 410 J822

Descriptors: rat, male, female, isolation socially reared, aggression, behavior, body weight, stress.

Mailloux, J.G., et al. (1974). **Effects of differential rearing on cortical evoked potentials of the albino rat.** *Journal of Comparative and Physiological Psychology* 87(3):475-480.

NAL call number: 410 J822

Descriptors: rat, Sprague-Dawley, weanling, visual enrichment, auditory enrichment, electrodes.

Matysiak, J. and Z. Toeplitz (1990). **Influence of genetic and environmental factors on self-exposure to sensory stimuli in rats.** *Ricerche di Psicologia* 14(2):19-28.

Descriptors: rat, Wistar, Brown-Norway, male, environmental enrichment, behavioral tests.

Mazurski, E.J. (1994). **Handling and emotionality in laboratory rats.** In: *Improving the Well-being of Animals in the Research Environment: Proceedings of the conference held at the Marriott Hotel, Sydney, October, 1993* R.M. Bak er, G. Jenkin, and D.J. Mellor, eds., Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART):Glen Osmond, SA, Australia, pp. 81-85.

NAL call number: SF406 I46 1993

Descriptors: rat, handling, behavior, learning, aggressiveness, stress, fear, physiological responses.

- McKee, J., P. Harrison, H. Gonyou, G. Riskowski, L. Sebek, and R. Maghirang (1993). **Effect of double density housing of laboratory rats in simulated space shuttle transport caging.** *FASEB Journal* 7(3-4):A620.
NAL call number: QH301 F3
Descriptors: rat, housing, cardiovascular system, abstract.
- Menzaghi, F., S.C. Heinrichs, E. Merlo-Pich, F.J. Tilders, and G.F. Koob (1994). **Involvement of hypothalamic corticotropin-releasing factor neurons in behavioral responses to novelty in rats.** *Neuroscience Letters* 168(1-2):139-142.
NAL call number: QP351 N3
Descriptors: rat, paraventricular nucleus, locomotor activity, novel environments, housing, ricin A toxin, stress.
- Mills, D.E., Y.S. Huang, M. Narce, and J.P. Poisson (1994). **Psychosocial stress, catecholamines, and essential fatty acid metabolism in rats.** *Proceedings of the Society for Experimental Biology and Medicine* 205(1):56-61.
NAL call number: 442.9 So1
Descriptors: rat, Wistar-Kyoto, normotensive, spontaneously hypertensive, Sprague-Dawley, epinephrine, isolation, group-reared, fatty acid desaturase.
- Mirmiran, M., and H.B. Uylings (1983). **The environmental enrichment effect upon cortical growth is neutralized by concomitant pharmacological suppression of active sleep in female rats.** *Brain Research* 261(2):331-334.
Descriptors: rat, female, REM sleep, clonidine, brain weight, cortex.
- Mitani, K. (1975). **Enhancement of general activity in the white rat through rearing in enriched environment.** *Annual of Animal Psychology* 24(2):73-85.
Descriptors: rat, male, environmental enrichment, cage size, toys, open field, activity, body weight, urination, defecation.
- Mohamed, A.K., B. Winblad, T. Ebendal, and T. Larkfors (1990). **Environmental influence on behaviour and nerve growth factor in the brain.** *Brain Research* (Netherlands) 528(1):62-72.
NAL call number: Film S-1779
Descriptors: rat, Morris maze, nerve growth factor, septohippocampal pathway, Alzheimer's disease, environmental stimulation.
- Mohammed, A.H., B.G. Henriksson, S. Soderstrom, T. Ebendal, T. Olsson, and J.R. Seckl (1993). **Environmental influences on the central nervous system and their implications for the aging rat.** *Behavioural Brain Research* 57(2):183-191.
Descriptors: rat, adult, old, neuronal plasticity, environmental enrichment, handling, glucocorticoid receptors, hippocampus, nerve growth factor.
- Moore, C.L. and K.L. Power (1992). **Variation in maternal care and individual differences in play, exploration, and grooming of juvenile Norway rat offspring.** *Developmental Psychobiology* 25(3):165-182.
NAL call number: QP351 D4
Descriptors: rat, Norway, female, neonate, mothers, maternal anogenital licking, licking, time in nest, nursing, zinc sulfate, dietary saline.
- Morgensen, J. (1991). **Influences of the rearing conditions on functional properties of the rat's prefrontal system.** *Behavioural Brain Research* (Netherlands) 42(2):135-142.
Descriptors: rat, male, visual pattern discrimination, maze, spatial delayed alternation, cortex.
- Morinah, A. and B.E. Leonard (1980). **Some anatomical and physiological correlates of social isolation in the young rat.** *Physiology and Behavior* 24:637-640.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, weanling, isolation, socially reared, ascorbic acid, corticosterone, cortex, stress.
- Morseth, S.L., H.A. Dengerink, and J.W. Wright (1985). **Effect of impulse noise on water consumption and blood pressure in the female rat.** *Physiology and Behavior* 34:1013-1016.

NAL call number: QP1 P4

Descriptors: rat, Sprague-Dawley, female, adult, impulse noise, drinking, blood pressure.

Muir, J.L., P.H. Pfister, and A. Ivinskis (1985). **Effects of prepartum stress and postpartum enrichment on mother-infant interaction and offspring problem-solving ability in *Rattus norvegicus*.** *Journal of Comparative Psychology* 99(4):468-478.

NAL call number: BF671 J6

Descriptors: rat, Wistar, female, behavior, Hebb-Williams maze, closed field.

Mulligan, B.E., S.C. Baker, and M.R. Murphy (1994). **Vocalizations as indicators of emotional state and psychological wellbeing in animals.** *Animal Welfare Information Center Newsletter* 5(3):3-4.

NAL call number: aHV4701 A952

Descriptors: rats, macaques, vocalizations, emotionality.

Murtha, S., B.A. Pappas, and S. Raman (1990). **Neonatal and adult forebrain norepinephrine depletion and the behavioral and cortical thickening effects of enriched/impooverished environment.** *Behavioural Brain Research* (Netherlands) 39(3):249-261.

Descriptors: rat, neonate, adult, Hebb-Williams maze, 6-OHDA, bupropion, depletion, learning.

Nayfield, K.C. and E.L. Beach (1981). **Comparative responses of rabbits and rats to elevated noise.** *Laboratory Animal Science* 31(4):386-390.

NAL call number: 410.9 P94

Descriptors: rat, rabbit, male, noise, adrenal gland, spleen, hematology, feed consumption, body weight, organ weight.

Nilsson, L., A.K.H. Mohammed, B.G. Henriksson, R. Folkesson, and B. Winblad (1993). **Environmental influence on somatostatin levels and gene expression in the rat brain.** *Brain Research* 628(1-2):93-98.

NAL call number: Film S-1779

Descriptors: rat, preprosomatostatin-mRNA, impoverished, environmental enrichment, spatial learning, open field, locomotor activity, cortex, hypothalamus.

Nott, H.M.R. and R.M. Sibly (1993). **Response to novel food by rats: Effects of social rank.** *Crop Protection* 12(2):89-94.

NAL call number: SB599 C8

Descriptors: rat, dominant, subdominant, neophobia, feeding.

Oehler, J., M. Jahkel, and J. Schmidt (1987). **Neuronal transmitter sensitivity after social isolation in rats.** *Physiology and Behavior* 41(3):187-191.

NAL call number: QP1 P4

Descriptors: rat, Wistar, male, isolation, neurotransmitter, dopaminergic, noradrenergic, serotonergic.

Olsson, T., A.H. Mohammed, L.F. Donaldson, B.G. Henriksson, and J.R. Seckl (1994). **Glucocorticoid receptor and NGFI-A gene expression are induced in the hippocampus after environmental enrichment in adult rats.** *Molecular Brain Research* 23(4):349-353.

Descriptors: rat, adult, nerve growth factor, hippocampus, mineralocorticoid receptor, transcription factor.

Ough, B.R., W.W. Beatty, and J. Khalili (1972). **Effects of isolated and enriched rearing on response inhibition.** *Psychonomic Science* 27(5):293-294.

Descriptors: rat, environmental enrichment, isolation, DRL-20 task, food reward, CRF.

Pacteau, C., D. Einon, and J. Sinden (1989). **Early rearing environment and dorsal hippocampal ibotenic acid lesions: Long-term influences on spatial learning and alternation in the rat.** *Behavioral Brain Research* 34(1-2):79-96.

Descriptors: rat, female, weanling, environmental enrichment, social isolation, chemical vs. electrical lesions, learning.

Panksepp, J. (1981). **The ontogeny of play in rats.** *Developmental Psychobiology* 14(4):327-332.

NAL call number: QP351 D4

Descriptors: rat, Long-Evans, weaning, young, pinning behavior, isolation, dominance.

Pappas, B.A., M. Saari, J. Smythe, S. Murtha, et al.. **Forebrain norepinephrine and neurobehavioral plasticity: Neonatal 6-hydroxydopamine eliminates enriched-impoverished experience effects on maze performance.**

Pharmacology, Biochemistry, and Behavior 27(1):153-158.

NAL call number: QP901 P4

Descriptors: rat, male newborn, weanling, 6-OHDA, maturation, Lashley maze, Hebb-Williams maze.

Pappas, B.A., G. Vickers, J. Gallivan, and M. Buxton (1981). **Neuro-pharmacological and environmental (home cage bedding) influences on infant rat activity.** *Progress in Neuro-Psychopharmacology* 5(3):307.

Descriptors: rat, neonate, abstract.

Pappas, B.A., S.J.E. Murtha, G.A.S. Park, K.T. Condon, R.M. Szirtes, S.I. Laventure, and A. Ally (1992). **Neonatal brain dopamine depletion and the cortical and behavioral consequences of enriched postweaning environment.**

Pharmacology, Biochemistry, and Behavior (USA) 42(4):741-748.

NAL call number: QP901 P4

Descriptors: rat, male, water maze, 6-OHDA, cognition.

Pare, W.P. and G.P. Vincent (1989). **Environmental enrichment, running behavior and activity-stress ulcer in the rat.** *Medical Science Research* 17(1):35-36.

Descriptors: rat, hypertensive, Wistar-Kyoto, running wheel, genetics.

Park, G.A.S., B.A. Pappas, S.M. Murtha, and A. Ally (1992).

Enriched environment primes forebrain choline acetyltransferase activity to respond to learning experience.

Neuroscience Letters (Ireland) 143(1-2):259-262.

NAL call number: QP351 N3

Descriptors: rat, weanling, water maze, caudate, training.

Parsons, P.J. and N.E. Spear (1972). **Long-term retention of avoidance learning by immature and adult rats as a function of environmental enrichment.** *Journal of Comparative and Physiological Psychology* 80(2):297-303.

NAL call number: 410 J822

Descriptors: rat, Sprague-Dawley, female, weanling, adult, handling, avoidance learning, electric shock, memory.

Pascual, R., V. Fernandez, S. Ruiz, and R.O. Kuljis (1993). **Environmental deprivation delays the maturation of motor pyramids during the early postnatal period.** *Early Human Development* 33(2):145-155.

NAL call number: RG600 E27

Descriptors: rat, Sprague-Dawley, male, female, neonate, morphometrics, pyramidal neurons, dendrites, cortex, malnutrition.

Paylor, R., S.K. Morrison, J.W. Rudy, L.T. Waltrip, and J.M. Wehner (1992). **Brief exposure to an enriched environment improves performance on the Morris water task and increases hippocampal cytosolic protein kinase C activity in the young rat.** *Behavioural Brain Research* 52(1):49-56.

Descriptors: rat, neonate, water maze, hippocampus, protein kinase C, learning, memory.

Pellis, S.M., V.C. Pellis, and M.M. McKenna (1993). **Some subordinates are more equal than others play fighting amongst adult subordinate male rats.** *Aggressive Behavior* 19(5):385-393.

NAL call number: BF575 A3A57

Descriptors: rat, male, dominance, behavior, play.

Pellis, S.M., E. Castaneda, M.M. McKenna, L.T.L. Tran-Nguyen, and I.Q. Whishaw (1993). **The role of the striatum in organizing sequences of play fighting in neonatally dopamine-depleted rats.** *Neuroscience Letters* 158(1):13-15.

NAL call number: QP351 N3

Descriptors: rat, male, female, young, 6-hydroxydopamine, striatum, play fighting, allogrooming, sexual mounting.

- Perez, V.J., B.B. Thach, and J.L. Palet (1978). **S-100 protein: Regional CNS concentrations in rats raised in different environments.** *Developmental Psychobiology* 11(4):301-308.
NAL call number: QP351 D4
Descriptors: rat, Holtzman, female, post-weaning, toys, cerebellum, brainstem, protein turnover.
- Pogun, S., S. Demirgoren, F.Z. Kutay, and B. Okur (1992). **Learning induces changes in the central cholinergic system of the rat in a sexually dimorphic pattern.** *International Journal of Psychophysiology* 13(1):17-23.
Descriptors: rat, male, female, environmental enrichment, active avoidance learning, muscarinic receptors, acetylcholinesterase, choline acetyltransferase.
- Por, S.B., E.L. Bennett, and S.C. Bondy (1982). **Environmental enrichment and neurotransmitter receptors.** *Behavioral and Neural Biology* 34(2):132-140.
NAL call number: QH301 C63
Descriptors: rat, Berkeley S₁, binding assays, membrane fractions, cerebellum, subcortex, cortex.
- Potegal, M. and D. Einon (1989). **Aggressive behaviors in adult rats deprived of playfighting experience as juveniles.** *Developmental Psychobiology* 22(2):159-172.
NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, isolation, pairs, mouse-killing, intraspecific aggression, shock-induced fighting, thresholds.
- Rabe, A. and R.K. Haddad (1970). **Response of micrencephalic rates to environmental complexity.** *Proceedings of the Annual Convention of the American Psychological Association* 5(Pt.1):195-196.
Descriptors: rat, adult, chemically induced micrencephaly, Hebb-Williams maze.
- Ray, O.S. and S. Hochhauser (1969). **Growth hormone and environmental complexity effects on behavior in the rat.** *Developmental Psychobiology* 1(4):311-317.
NAL call number: BF712 D46
Descriptors: rat, female, pregnant, neonate, weanling, bovine growth hormone, reflex maturation, environmental enrichment, isolation, open field, Lashley III maze, shuttle box, learning.
- Raynor, T.H., W.H. Steinhagen, and T.E. Hamm, Jr. (1983). **Differences in the microenvironment of a polycarbonate caging system: Bedding vs. raised wire floor.** *Lab Animal* 17(2):85-89.
NAL call number: QL55 A1L3
Descriptors: rat, male, female, caging, bedding, floor type, ammonia, aerosols, temperature, humidity.
- Renner, M.J. and M.R. Rosenzweig (1986). **Social interactions among rats housed in group and enriched environments.** *Developmental Psychobiology* 19(4):303-313.
NAL call number: QP351 D4
Descriptors: rat, Berkeley S₁, brain weight, behavior, social factors.
- Renner, M.J. and C.H. Renner (1993). **Expert and novice intuitive judgements about animal behavior.** *Bulletin of the Psychonomic Society* 31(6):551-552.
Descriptors: rat, environmental enrichment, impoverished, observations, training.
- Rethlingshafer, D. and L.R. Arrington (1966). **Problem solving in B1 deficit rats reared in enriched and restricted environments.** *Proceedings of the 74th Annual Convention of the American Psychological Association* 1966:3-4.
Descriptors: rat, vitamin B₁, complete diet, Hebb-Williams maze.
- Richardson, R., M.A. Siegel, and B.A. Campbell (1988). **Unfamiliar environments impair information processing as measured by behavioral and cardiac orienting response to auditory stimuli in preweanling and adult rats.** *Developmental Psychobiology* 21(5):491-503.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, adult, orienting response, auditory stimulus, heart rate, isolation, socially reared.

- Rieg, T.S., L.E. Doerries, J.G. O'Shea, and P.F. Aravich (1993). **Water deprivation produces an exercise-induced weight loss phenomenon in the rat.** *Physiology and Behavior* 53(3):607-610.
NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, feed restriction, running wheel, body weight, exercise, anorexia nervosa, vasopressin, blood chemistry.
- Riege, W.H. and H. Morimoto (1970). **Effects of chronic stress and differential environments upon brain weights and biogenic amine levels in rats.** *Journal of Comparative and Physiological Psychology* 71(3):396-404.
NAL call number: 410 J822
Descriptors: rat, Berkeley S₁, Fischer, tumbling stress, norepinephrine, dopamine, serotonin, environmental enrichment, impoverished, adrenal glands, cortex, hypothalamus, midbrain, brain weight.
- Rinck, C. (1968). **The effect of enriched environment and handling on the learning of a visual discrimination task.** *Psychonomic Science* 12(7):317-318.
Descriptors: rat, environmental enrichment, impoverished, handling, emotionality, exploration.
- Rockman, G.E. and J.E.M. Gibson (1992). **Effects of duration and timing of environmental enrichment on voluntary ethanol intake in rats.** *Pharmacology, Biochemistry, and Behavior* (USA) 41(4):689-693.
NAL call number: QP901 P4
Descriptors: rat, male, weanling, ethanol.
- Rockman, G.E., J.E. Gibson, and A. Benarroch (1989). **Effects of environmental enrichment on voluntary ethanol intake in rats.** *Pharmacology, Biochemistry, and Behavior* 34(3):487-490.
NAL call number: QP901 P4
Descriptors: rat, male, weanling, isolation, water consumption.
- Rockman, G.E., T.B. Borowski, and G.B. Glavin (1986). **The effects of environmental enrichment on voluntary ethanol consumption and stress ulcer formation in rats.** *Alcohol* 3(5):299-302.
Descriptors: rat, weanling, immobilization, ulcers.
- Rockman, G.E., A.M. Hall, L.E. Market, and G.B. Glavin (1988). **Influence of rearing conditions on voluntary ethanol intake and response to stress in rats.** *Behavioral and Neural Biology* 49(2):184-191.
NAL call number: QH301 C63
Descriptors: rat, male, weanling, immobilization, ulcers.
- Rodriguez Enchandia, E.L., A.S. Gonzalez, R. Cabrera, and L.N. Fracchia (1988). **A further analysis of behavioral and endocrine effects of unpredictable chronic stress.** *Physiology and Behavior* 43(6):789-795.
NAL call number: QP1 P4
Descriptors: rat, male, female, depression, emotional stress, physical stress, motor activity, exploration, corticosterone, prolactin.
- Rose, F.D., K. al-Khamees, M.J. Davey, and E.A. Attree (1993). **Environmental enrichment following brain damage: An aid to recovery or compensation?** *Behavioural Brain Research* 56(1):93-100.
Descriptors: rat, prelesion performance vs. postlesion performance, water maze, escape response, bilateral occipital lesions.
- Rose, F.D., M.J. Davey, and E.A. Attree (1993) **How does environmental enrichment aid performance following cortical injury in the rat?** *Neuroreport* 4(2):163-166.
Descriptors: rat, cortex, brain damage, water maze, learning.
- Rose, F.D., M.J. Davey, K. Al-Khamees, and E.A. Attree (1992). **General adaptive capacity and recovery of function following cortical damage in the rat.** *Medical Science Research* 20(10):359-360.
Descriptors: rat, bilateral lesions, occipital cortex, water maze, environmental enrichment, learning.

- Rose, F.D., M.J. Davey, S. Love, and P.A. Dell (1987). **Environmental enrichment and recovery from contralateral sensory neglect in rats with large unilateral neocortical lesions.** *Behavioural and Brain Research* 24(3):195-202.
Descriptors: rat, compensation vs. recovery, bracelet removal test, postoperative.
- Rose, F.D., P.A. Dell, and S. Love (1987). **An analysis of reinforcement in rats reared in enriched and impoverished environments.** *Medical Science Research: Psychology and Psychiatry* 15(9-12):717-718.
Descriptors: rat, male, Lister hooded, reward, behavior, operant learning.
- Rose, F.D., P.A. Dell, and S. Love (1985). **Behavioural consequences of different types of environmental enrichment in the rat.** *IRCS Medical Science* 13(8):748-749.
Descriptors: rat, behavior, methods.
- Rose, F.D., P.A. Dell, S. Love, and M.J. Davey (1989). **Post-surgical environmental enrichment and functional recovery in the hemidecorticate rat: Alternative interpretations.** *Medical Science Research* 17(11):481-483.
Descriptors: rat, male, open field test, attention test, grip test, new learning vs. established learning.
- Rose, F.D., P.A. Dell, S. Love, and M.J. Davey (1988). **Environmental enrichment and recovery from a complex G0/No-Go reversal deficit in rats following large unilateral neocortical lesions.** *Behavioural Brain Research* 31(1):37-45.
Descriptors: rat, operant task, behavior, hemidecorticate deficit.
- Rose, F.D. and P.J. Lamden (1983). **GO NO-GO learning in rats reared in enriched and impoverished environments.** *IRCS Medical Science: Psychology and Psychiatry* 11(5-6):433-434.
Descriptors: rat, Hooded Lister, male, auditory discrimination, learning.
- Rose, F.D., S. Love, and P.A. Dell (1986). **Differential reinforcement effects in rats reared in enriched and impoverished environments.** *Physiology and Behavior* 36(6):1139-1145.
NAL call number: QP1 P4
Descriptors: rat, learning, lever-press training, response-contingent events.
- Rose, F.D., S. Love, P.A. Dell, and M.J. Davey (1988). **Environmental attenuation of DRL performance in the rat following hemidecortication.** *Medical Science Research* 16(11):563-564.
Descriptors: rat, male, Skinner box, differential reinforcement, error inhibition.
- Rosenzweig, M.R. and E.L. Bennett (1972). **Cerebral changes in rats exposed individually to an enriched environment.** *Journal of Comparative and Physiological Psychology* 80(2):304-313.
NAL call number: 410 J822
Descriptors: rat, Berkeley S₁, male, methamphetamine, brain weight, brain enzymes, light vs. dark.
- Rosenzweig, M., E.L. Bennett, and M.C. Diamond (1972). **Cerebral effects of differential experience in hypophysectomized rats.** *Journal of Comparative and Physiological Psychology* 79(1):56-66.
NAL call number: 410 J822
Descriptors: rat, Fischer, Long-Evans, male, environmental enrichment, impoverished, brain weight, cortex, lesions, acetylcholinesterase, cholinesterase, pituitary.
- Sanchez-Toscano, F., M.M. Sanchez, and J. Garzon (1991). **Changes in the number of dendritic spines in the medial preoptic area during a premature long-term social isolation in rats.** *Neuroscience Letters* 122(1):1-3.
NAL call number: QP351 N3
Descriptors: rat, male, neonates, premature weaning, Golgi study, dendrites, isolation, postsynaptic structures, stress.
- Satinder, K.P. (1967). **Effects of bedding material on survival probability, body weight and open-field behaviour in rat.** *Psychological Reports* 21(3):954-956.
Descriptors: rat, female, learning, behavior.
- Schaefer, G.J. and R.P. Michael (1991). **Housing conditions alter the acquisition of brain self-stimulation and**

locomotor activity in adult rats. *Physiology and Behavior* 49(3):635-638.

NAL call number: QP1 P4

Descriptors: rat, male, electrodes, medial forebrain bundle, lateral hypothalamus, group reared, isolation, handling, locomotion, unconditioned behavior.

Schmorrow, D.D. and R.E. Ulrich (1991). **Improving the housing and care of laboratory pigeons and rats.** *Humane Innovations and Alternatives* 5:299-305.

NAL call number: QL55 H8

Descriptors: rat, caging, space requirements, animal welfare.

Schuster, R., B.D. Berger, and H.H. Swanson (1994). **Cooperative social coordination and aggression: II. Effects of sex and housing among three strains of intact laboratory rats differing in aggressiveness.** *Quarterly Journal of Experimental Psychology (B):Comparative and Physiological Psychology* 46(4):367-390.

Descriptors: rat, S3, Charles River, Wistar, synchronized shuttling, pair housing, isolation, behavior, learning.

Schwandt, L.M. (1993). **Individual versus group housing affects nociception independently of housing status during development.** *Bulletin of the Psychonomic Society* 31(6):525-528.

Descriptors: rat, isolation, housing, pain reception, electric shock, stress-induced hypoalgesia, stress.

Selseth, K.J. and E.D. Kemble (1988). **Fluprazine hydrochloride decreases play behavior but not social grooming in juvenile male rats.** *Bulletin of the Psychonomic Society* 26(6):563-564.

Descriptors: rats, male, young, attack, male copulation, maternal behavior, fear.

Seybold, K.S., P. Wampler-Parsons, H.A. Murphy, R. Magee, and R.L. Port (1993). **Modest environmental enrichment improves cognitive performance of aged rats.** *Society for Neuroscience Abstracts* 19(1-3):600.

NAL call number: QP351 S6

Descriptors: rat, old, behavior, memory.

Sharp, P.E., C.A. Barnes, and B.L. McNaughton (1987). **Effects of aging on environmental modulation of hippocampal evoked responses.** *Behavioral Neuroscience* 101(2):170-178.

NAL call number: QP351 B45

Descriptors: rat, young, old, dentate gyrus, evoked responses.

Siegel, M.A. and R.A. Jensen (1986). **The effects of naloxone and cage size on social play and activity in isolated young rats.** *Behavioral and Neural Biology* 45(2):155-168.

NAL call number: QH301 C63

Descriptors: rat, Long-Evans, male, young, pinning behavior, socialization, activity, play behavior.

Sirevaag, A.M., J.E. Black, D. Shafron, and W.T. Greenough (1988). **Direct evidence that complex experience increases capillary branching and surface area in visual cortex of young rats.** *Developmental Brain Research* 43(2):299-304.

Descriptors: rat, adolescent, toys, enrichment, angiogenesis.

Siviy, S.M. and J. Panksepp (1987). **Sensory modulation of juvenile play in rats.** *Developmental Psychobiology* 20(1):39-55.

NAL call number: QP351 D4

Descriptors: rat, Long-Evans, somatosensory input, xylocaine, local anesthesia, dorsal body, pinning, play motivation.

Siviy, S.M. and D.M. Atrens (1992). **The energetic costs of rough-and-tumble play in the juvenile rat.** *Developmental Psychobiology* 25(2):137-148.

NAL call number: QP351 D4

Descriptors: rat, young, indirect calorimetry, energy expenditure, play, play restricted, body weight, feed consumption.

Slagle, R.W. (1969). **The effects of specialized environmental enrichment on brain and behavior of rats.** *Dissertation Abstracts* 29(9-B):3518.

NAL call number: Z5055.U49D53

Descriptors: rat, environmental enrichment.

Slentz, C.A. and J.O. Holloszy (1993). **Body composition of physically inactive and 25-month-old female rats.** *Mechanisms of Aging and Development* 69(3):161-166.

NAL call number: QP84 M4

Descriptors: rat, Long-Evans, female, isolation, running wheel, feed intake, body fat, body mass, body protein, body weight.

Smart, J.L., A.C. McMahon, R.F. Massey, G.-N.K. Akbar, and M.A. Warren (1990). **Evidence of non-maternally mediated acceleration of eye-opening in "enriched" artificially reared pups.** *Developmental Brain Research* (Netherlands) 56(1):141-143.

Descriptors: rat, neonates, eye-opening, gentling, social interaction, homing.

Smith, H.V. (1972). **Effects of environmental enrichment on open field activity and Hebb-Williams problem solving in rats.** *Journal of Comparative and Physiological Psychology* 80(1):163-168.

NAL call number: 410 J822

Descriptors: rat, Carworth Europe, male, female, impoverished, test order, activity, defecation, maze, exploration.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the Turkestan rat, *Rattus turkestanicus*.** *Zoologicheskij zurnal* 72(6):124-129.

NAL call number: 410 R92

Descriptors: rat, Turkestan, activity, dominance.

Sokolov, V.E. and S.A. Kvashnin (1993). **A comparative study of play behavior in 3 species of rattus (Rodentia, Muridae).** *Zoologicheskij Zhurnal* 72(11):126-139.

NAL call number: 410 R92

Descriptors: rat, Norwegian, Black, Turkestan, male, female, age.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the black rat, *Rattus rattus*.** *Zoologicheskij zurnal* 72(5):132-141.

NAL call number: 410 R92

Descriptors: rat, Black, male, female, age, behavior, activity.

Speiler, K., P. Schoch, J.R. Martin, and W. Haefely (1993). **Environmental stimulation promotes changes in the distribution of phorbol ester receptors.** *Pharmacology, Biochemistry, and Behavior* 46(3):553-560.

NAL call number: QP901 P4

Descriptors: rat, female, protein kinase C, learning, memory, [³H]-PDBu, receptor binding, cortex, hippocampus, radial maze, environmental enrichment.

Spencer, P.J., J.L. Mattsson, K.A. Johnson, and R.R. Albee (1993). **Neurotoxicity screening methods are sensitive to experimental history.** *International Journal of Psychophysiology* 14(1):5-19.

Descriptors: rat, exercise, handling, neurotoxicity, evoked potentials, motor activity, histopathology.

Strupp, B.J. and D.A. Levitsky (1984). **Social transmission of food preferences in adult hooded rats (*Rattus norvegicus*).** *Journal of Comparative Psychology* 98(3):257-266.

NAL call number: BF671 J6

Descriptors: rat, Long-Evans, hooded, male, social learning.

Sturgeon, R.D. and L.D. Reid (1971). **Rearing variations and Hebb-Williams maze performance.** *Psychological Reports* 29(2):571-580.

Descriptors: rat, hooded, male, weanling, young, environmental enrichment, impoverished, pretraining, problem solving.

Sucheki, D., P. Rosenfield, and S. Levine (1993). **Maternal regulation of the hypothalamic-pituitary-adrenal axis in**

the infant rat: The role of feeding and stroking. *Developmental Brain Research* 75(2):185-192.

Descriptors: rat, female, neonate, corticosterone, maternal separation, feeding, stroking.

Susser, E.R. and R.B. Wallace (1982). **The effects of environmental complexity on the hippocampal formation of the adult rat.** *Acta Neurobiologiae Experimentalis* 42(2):203-207.

NAL call number: 442.8 AC8

Descriptors: rat, Long-Evans, male, dorsal hippocampus, brain weight, granule cells, plasticity.

Swanson, H.H., et al. (1983). **Interaction between pre-weaning undernutrition and post-weaning environmental enrichment on somatic development and behaviour in male and female rats.** *Behavioural Processes* 8(1):1-20.

NAL call number: QL750 B4

Descriptors: rat, Wistar, male, female, neonate, young, growth, sexual maturation, behavior, brain weight, toys.

Swanson, H.H. and N.E. Van De Poll (1983). **Effects of an isolated or enriched environment after handling on sexual maturation and behavior in male and female rats.** *Journal of Reproduction and Fertility* 69:165-171.

NAL call number: 442.8 J8222

Descriptors: rat, Wistar, male, female, handling, toys, ladders, ropes, tubes, isolation, socially reared, behavior, sexual behavior, body weight, organ weight.

Symons, L.A. and R.C. Tees (1990). **An examination of the intramodal and intermodal behavioral consequences of long-term vibrissae removal in rats.** *Developmental Psychobiology* 23(8):849-867.

NAL call number: QP351 D4

Descriptors: rat, male, environmental enrichment, cauterization vs. plucking, tactile stimuli, visual stimuli.

Tachibana, T. (1979). **Effects of early nutritional and environmental conditions on later runway test behavior in rats.** *Japanese Psychological Research* 21(2):99-102.

Descriptors: rat, Sprague-Dawley, malnutrition, environmental enrichment, isolation, runway.

Tagney, J. (1973). **Sleep patterns related to rearing rats in enriched and impoverished environments.** *Brain Research* 53:353-361.

NAL call number: Film S-1779

Descriptors: rat, male, weanling, electro-oculogram, EEG, EMG, slow wave, REM.

Takahashi, L.K., C. Haglin, and N.H. Kalin (1992). **Prenatal stress potentiates stress-induced behavior and reduces the propensity to play in juvenile rats.** *Physiology and Behavior* 51(2):219-323.

NAL call number: QP1 P4

Descriptors: rat, male, female, siblings, juvenile, social play, foot shock, tonic immobility, corticosteroids.

Tanabe, G. (1972). **Remediating maze deficiencies by the use of environmental enrichment.** *Developmental Psychology* 7(2):224.

NAL call number: BF712 D46

Descriptors: rat, Wistar, male, female, pregnancy, lactation, malnutrition, isolation, learning.

Taylor, A.J., S. Gordon, and R.D. Tee (1994). **Influence of bedding, cage design, and stock density on rat urinary aeroallergen levels.** *American Journal of Industrial Medicine* 25(1):89.

Descriptors: rat, allergens, occupational exposure.

Thor, D.H. and W.R. Holloway (1984). **Developmental analyses of social play behavior in juvenile rats.** *Bulletin of the Psychonomic Society* 22(6):587-590.

Descriptors: rat, male, female, ontogenetic descriptions, rough and tumble play, sexual maturity, aggression.

Tobin, B.W., J.L. Beard, and W.L. Kenney (1993). **Exercise training alters feed efficiency and body composition in iron deficient rats.** *Medicine and Science in Sports and Exercise* 25(1):52-59.

Descriptors: rat, training, exercise, growth, diet.

- Uylings, H.B., K. Kuypers, M.C. Diamond, W.A. Veltman (1978). **Effects of differential environments on plasticity of dendrites of cortical pyramidal neurons in adult rats.** *Experimental Neurology* 62(3):658-677.
NAL call number: RC321.E96
Descriptors: rat, male, Berkeley S₁, cortex, dendrites, length, branching, environmental enrichment.
- Van Gool, W.A. and M. Mirmiran (1986). **Effects of aging and housing in an enriched environment on sleep-wake patterns in rats.** *Sleep* 9(2):335-347.
Descriptors: rat, male, adult, old, slow wave, desynchronized sleep, adaptation.
- Van Gool, W.A., M. Mirmiran, and F. Van Haaren (1985). **Spatial memory and visual evoked potentials in young and old rats after housing in an enriched environment.** *Behavioral and Neural Biology* 44(3):454-469.
NAL call number: QH301 C63
Descriptors: rat, adult, old, radial maze, paired flashes, visual sensitivity, hippocampal changes.
- Van Gool, W.A., H.F. Pronker, M. Mirmiran, and H.B.M. Uylings (1987). **Effect of housing in an enriched environment on the size of the cerebral cortex in young and old rats.** *Experimental Neurology* 96(1):225-232.
NAL call number: RC321 E96
Descriptors: rat, adult, old, caging, toys, cortical plasticity.
- Van Haaren, F.P., and A. Van Hest (1987). **Old, but not worn out. [Oud, maar niet versleten.] Special Issue: The elderly and psychology.** *Psycholoog* 22(11):510-513.
Descriptors: rat, adult, aging, environmental enrichment, social deprivation, memory loss, problem solving, circadian activity.
- Venable, N., V. Fernandez, E. Diaz, and T. Pinto-Hamuy (1989) **Effects of preweaning environmental enrichment on basilar dendrites of pyramidal neurons in occipital cortex: A Golgi study.** *Developmental Brain Research* 49(1):140-144.
Descriptors: rat, neonates, cortical dendrites, Golgi-Cox-Sholl stain.
- Venable, N., T. Pinto-Hamuy, J.A. Arraztoa, M.T. Contador, A. Chellew, C. Peran, and X. Valenzuela (1988). **Greater efficacy of preweaning than postweaning environmental enrichment on maze learning in adult rats.** *Behavioural Brain Research* 31(1):89-92.
Descriptors: rat, adult, Hebb-Williams maze, development.
- Vore, D.A. and D.R. Ottinger (1970). **Maternal food restriction: Effects on offspring development, learning, and a program of therapy.** *Developmental Psychology* 3(3, Pt.1):337-342.
NAL call number: BF712 D46
Descriptors: rat, Purdue Wistar, female, malnutrition, estrus, gestation, lactation, foster mothers, body weight, T-maze, Hebb-Williams maze.
- Walker, J.P. (1973). **The effects of enriched environment and isolation upon catecholamine metabolism in various brain regions.** *Dissertation Abstracts International* 33(9-B):4497.
NAL call number: Z5055.U49D53
Descriptors: rat, hypothalamus, cerebellum, caudate nucleus.
- Wallace, R.J. (1988). **Latency measures indicate new place neophobia in *Rattus* species.** *Behavioural Processes* 17(1):63-67.
NAL call number: QL750 B4
Descriptors: rat, novel places, exploration, home cage, lighting.
- Weldon, D.A. and C.J. Smith (1979). **Superior colliculus lesions and environmental experience: Nonvisual effects on problem solving and locomotor activity.** *Physiology and Behavior* 23(1):159-165.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, bilateral lesions, environmental enrichment, closed field, open field, illumination, vision.

- Wells, A.M. **The effect of dietary and environmental conditions on performance of rats in the Hebb-Williams maze.** *Dissertation Abstracts International* 32(1-B):600-601.
NAL call number: Z5055.U49D53
Descriptors: rat, neonate, environmental enrichment, impoverished.
- Wells, A.M., C.R. Geist, and R.R. Zimmerman (1972). **Influence of environmental and nutritional factors on problem solving in the rat.** *Perceptual and Motor Skills* 35(1):235-244.
Descriptors: rat, Holtzman, male, neonate, foster mothers, dietary protein, environmental enrichment, spatial, visual, tactile, impoverished, Hebb-Williams maze.
- Whishaw, I.Q., R.J. Sutherland, B. Kolb, and J.B. Becker (1986). **Effects of neonatal forebrain noradrenaline depletion on recovery from brain damage: Performance on a spatial navigation task as a function of age of surgery and postsurgical housing.** *Behavioral and Neural Biology* 46(3):285-307.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, neonate, adult, hemidecortication, noradrenaline, environmental enrichment.
- Whishaw, I.Q., J.-A. Zaborowski, and B. Kolb (1984). **Postsurgical enrichment aids adult hemidecorticate rats on a spatial navigation task.** *Behavioral and Neural Biology* 42(2):183-190.
NAL call number: QP351 B45
Descriptors: rat, neonate, adult, cortex, Morris water maze, outdoors.
- White, W.J. and A.M. Mans (1984). **Effect of bedding changes and room ventilation rates on blood and brain ammonia levels in normal rats and rats with portacaval shunts.** *Laboratory Animal Science* 34(1):49-52.
NAL call number: 410.9 P94
Descriptors: rat, Long-Evans, male, bedding, air pollution.
- White, N.R. and R.J. Barfield (1989). **Playback of female rat ultrasonic vocalizations during sexual behavior.** *Physiology and Behavior* 45(2):229-233.
NAL call number: QP1 P4
Descriptors: rat, female, male, devocalized, intact, darting.
- Widman, D.R., G.C. Abrahamsen, and R.A. Rosellini (1992). **Environmental enrichment: The influences of restricted daily exposure and subsequent exposure to uncontrollable stress.** *Physiology and Behavior* 51(2):309-318.
NAL call number: QP1 P4
Descriptors: rat, male, stress, operant tasks, pavlovian tasks, learning.
- Widman, D.R. and R.A. Rosellini (1990). **Restricted daily exposure to environmental enrichment increases the diversity of exploration.** *Physiology and Behavior* 47(1):57-62.
NAL call number: QP1 P4
Descriptors: rat, male, object exploration test, environmental exposure.
- Will, B.E., et al. (1977). **Relatively brief environmental enrichment aids recovery of learning capacity and alters brain measures after postweaning brain lesions in rats.** *Journal of Comparative and Physiological Psychology* 91(1):33-50.
NAL call number: 410 J822
Descriptors: rat, Fischer, Berkeley S₁, male, bilateral lesions, occipital cortex, hippocampus, Hebb-Williams maze, methamphetamine, brain weight, RNA, DNA.
- Will, B., C. Kelche, and F. Deluzarche (1981). **Effects of post-operative environment on functional recovery after entorhinal cortex lesions in the rat.** *Behavioral and Neural Biology* 33(3):303-316.
NAL call number: QH301 C63
Descriptors: rat, young, bilateral lesions, entorhinal cortex, Hebb-Williams maze, learning.
- Will, B.E., F. Deluzarche, and C. Kelche (1983). **Does post-operative environment attenuate or exacerbate**

symptoms which follow hippocampal lesions in rats? *Behavioural Brain Research* 7(1):125-132.

Descriptors: rat, hooded, female, spontaneous alternation, hippocampus.

Witvitskaya, L.V. (1983). **DNA synthesis in the brain of rats bred in sensorily enriched or impoverished environment.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 33(4):773-775.

Descriptors: rat, deprivation, brain, biochemistry.

Wolffgram, J. and A. Heyne (1991). **Social behavior, dominance, and social deprivation of rats determine drug choice.** *Pharmacology, Biochemistry, and Behavior* 38(2):389-399.

Descriptors: rat, Wistar, male, adult, ethanol, diazepam, quinine, open field, isolation, group housing, activity, body weight.

Wong, P.T.P., T. Roach, and B. Osborne (1975). **A sand-digging apparatus for rats.** *Behavior Research Methods and Instrumentation* 7(1):34-36.

Descriptors: rat, recording device, digging behavior, time.

Wu, S.Y.C. (1973). **Effects of enriched environment and visual deprivation on development of brain in rat.** *Acta Psychologica Taiwanica* 15:154-160.

Descriptors: rat, Berkeley S₁, neonate, brain weight, cortex, superior colliculi, acetylcholinesterase, butyrylcholinesterase.

Yamamoto, Y., T. Nakaya, and S. Kato (1988). **Influences of early rearing environment on Hebb-Williams maze learning in the rat: A comparison among group/imposed rich stimulation, group/poor stimulation, and isolation/poor stimulation.** *Annual of Animal Psychology* 37(2):99-114.

Descriptors: rat, weanling, adolescent, sensory stimuli, Hebb-Williams maze, learning.

Yeterian, E.H. and W.A. Wilson (1976). **Cross-modal transfer in rats following different early environments.** *Bulletin of the Psychonomic Society* 7(6):551-553.

Descriptors: rat, black-hooded, male, weanling, cross-modal transfer, visual discrimination, learning.

Zendzian-Piotrowska, M. and J. Gorski (1993). **Metabolic adaptation to daily exercise of moderate intensity to exhaustion in the rat.** *European Journal of Applied Physiology and Occupational Physiology* 67(1):77-82.

Descriptors: rat, male, treadmill, training, body mass, feed intake, glycogen, muscle fibers, heart, diaphragm, liver, hypoglycemia, urea.

Zimmerberg-Glick, B. and M.B. Brett (1992). **Effects of early environmental experience on self-administration of amphetamine and barbital.** *Psychopharmacology (Germany)* 106(4):474-478.

Descriptors: rat, male, female, social isolation, self-administration, d-amphetamine sulfate, sodium barbital.

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Wild Rodents

Christisen, D.M. (1985). **Seasonal tenancy of artificial nest structures for tree squirrels.** *Transactions of the Missouri Academy of Science* 19:41-48.

NAL call number: QC180 A1M52

Descriptors: tree squirrels (*Sciurus sp.*), den boxes, tire nest structures, housing.

Cooper, J.J. and C.J. Nichol (1991). **Stereotypic behaviour affects environmental preference in bank voles, *Clethrionomys glareolus*.** *Animal Behaviour* 41(6):971-977.

NAL call number: 410 B77

Descriptors: bank vole, preference test, perception, aversive conditions.

Escherich, P.C. (1981). **Social biology of the bushy-tailed woodrat, *Neotoma cinerea***. *Publications in Zoology* 110:132pp.

NAL call number: 500 C125Z v.110

Descriptors: Bushy-tailed wood rat, social behavior.

Faulkes, C.G. and D.H. Abbott (1993). **Evidence that primer pheromones do not cause social suppression of reproduction in male and female naked mole-rats (*Heterocephalus glaber*)**. *Journal of Reproduction and Fertility* 99(1):225-230.

NAL call number: 442.8 J8222

Descriptors: naked mole-rats, male, female, chemical cues, reproductive suppression, olfactory cues, gustatory contact, luteal phase, androgens.

Murphey, R.M., J.S. Mariano, and F.A. Duarte (1985). **Behavioral observations in a capybara colony (*Hydrochoerus hydrochaeris*)**. *Applied Animal Behaviour Science* 14(1):89-98.

NAL call number: QL750 A6

Descriptors: capybara, alarm response, flight or fight response, behavior.

Ödberg, F.O. (1987). **The influence of cage size and environmental enrichment on the development of stereotypies in bank voles (*Clethrionomys glareolus*)**. *Behavioural Processes* 14(2):155-173.

Descriptors: bank voles, behavior, conflicts.

Renner, M.J. and M.R. Rosenzweig (1987). **The golden-mantled ground squirrel (*Spermophilus lateralis*) as a model for the effects of environmental enrichment in solitary animals**. *Developmental Psychobiology* 20(1):19-24.

NAL call number: QP351 D4

Descriptors: ground squirrel, brain weight, behavior, social factors.

Rushen, J. (1993). **The "coping" hypothesis of stereotypic behavior**. *Animal Behaviour* 45(3):613-615.

NAL call number: 410 B77

Descriptors: bank voles (*Clethrionomys glareolus*), environmental enrichment, impoverished, perceptions, adverse environments.

Shiga, J., K. Yamamoto, M. Ito, K. Koshimizu (1989). **Breeding and care for wild woodchucks (*Marmota monax*) by indoor and outdoor housing**. *Jikken Dobutsu* 38(2):155-158.

NAL call number: QL55 J55

Descriptors: woodchuck, Japanese, English abstract, housing, reproduction.

Vogt, F.D. and P. Kakooza (1993). **The influence of nest sharing on the expression of daily torpor in the white-footed mouse**. *Canadian Journal of Zoology* 71(7):1297-1302.

NAL call number: 470 C16D

Descriptors: white-footed mouse (*Peromyscus leucopus noveboracensis*), huddling, isolation, radiotelemetry, body temperature, frequency of torpor, euthermic.

Wallace, J. (1994). **Evolution of ground squirrel housing at Biosciences Animal Service, University of Alberta**. *Canadian Association for Laboratory Animal Science/ L'Association Canadienne pour la Technologie des Animaux de Laboratoire Newsletter* 28(4):109-118.

NAL call number: SF405.5 C36

Descriptors: ground squirrel, housing, social groups, burrows, nests, vocalization, visual communication, tactile communication, olfactory communication.

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Journal Listing and Subscription Information for Selected Publications

"Journal Listing" and "Subscription Information for Selected Publications" are chapters from: Smith, C.P. and V. Taylor (September 1995). [Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents](#). *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 213-226.

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

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The following is a partial listing of journals that contain environmental enrichment and/or behavior articles covering the various species listed.

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Cats, Dogs, Rabbits

Title: *American Journal of Veterinary Research* (American Veterinary Medical Association).

Place of Publication: United States, Illinois

Language: English

International Standard Serial Number: 0002-9645

Descriptors: veterinary medicine periodicals.

NAL Call Number: 41.8 Am3A

Databases Indexed In: AGRICOLA, CAB ABSTRACTS, AGRIS

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).

Place of Publication: United Kingdom, England

Language: English

International Standard Serial Number: 0003-3472

Descriptors: animal behavior periodicals.

NAL Call Number: 410 B77

Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).

Place of Publication: United Kingdom, Wales

Language: English

International Standard Serial Number: 0264-4754

Descriptors: laboratory animals periodicals.

NAL Call Number: QL55.I5

Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)

Place of Publication: United Kingdom, England

Language: English

International Standard Serial Number: 0962-7286

Descriptors: animal welfare periodicals.

NAL Call Number: HV4701 A557

Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)

Place of Publication: United States, Maryland

Language: English

International Standard Serial Number: 1050-561X

Descriptors: animal welfare periodicals.

NAL Call Number: aHV4701.A952

Databases Indexed In: AGRICOLA

Title: *Anthrozoos* (Delta Society).

Place of Publication: United States, New Hampshire

Language: English

International Standard Serial Number: 0892-7936

Descriptors: human animal relationships periodicals, pet owners psychology periodicals, animal behavior periodicals.

NAL Call Number: SF411.A57

Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Applied Animal Behaviour Science*.

Place of Publication: Netherlands

Language: English

International Standard Serial Number: 0168-1591

Descriptors: animal behavior periodicals, domestic animals periodicals.

NAL Call Number: QL750.A6

Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Companion Animal Practice*.

Place of Publication: United States, California

Language: English

International Standard Serial Number: 0894-9794

Descriptors: veterinary medicine periodicals, pets diseases periodicals, cats diseases periodicals.

NAL Call Number: SF981.C64

Databases Indexed In: CAB ABSTRACTS, AGRICOLA

Title: *Lab Animal*.

Place of Publication: United States, New York

Language: English

International Standard Serial Number: 0093-7355
Descriptors: laboratory animals periodicals.
NAL Call Number: QL55.A1L33
Databases Indexed In: AGRICOLA, AGRIS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *The Veterinary Clinics of North America*.
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0091-0279
Descriptors: veterinary medicine collected works.
NAL Call Number: SF601.V523
Databases Indexed In: MEDLINE, CAB ABSTRACTS, AGRICOLA

Title: *The Veterinary Record: Journal of the British Veterinary Association*.
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0042-4900
Descriptors: veterinary medicine periodicals.
NAL Call Number: 41.8 V641
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Veterinary Technician*.
Place of Publication: United States, New Jersey
Language: English
International Standard Serial Number: Invalid :0196-1764
Descriptors: allied health personnel periodicals, laboratory animal technicians periodicals, veterinary medicine periodicals.
NAL Call Number: SF406.A5
Databases Indexed In: CAB ABSTRACTS

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Farm Animals

Title: *Animal Production* (British Society of Animal Production).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3561
Descriptors: Livestock-Periodicals, Animal-Industry-Great-Britain
NAL Call Number: 49 An55
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England

Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Applied Animal Behaviour Science*.
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *British Poultry Science* (Poultry Education Association).
Place of Publication: United Kingdom, Scotland
Language: English
International Standard Serial Number: 0007-1668
Descriptors: poultry periodicals.
NAL Call Number: 47.8 B77
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Canadian Journal of Animal Science* (Canadian Society of Animal Production).
Place of Publication: Canada, Ontario
Language: Includes Some Text in French, Abstracts in English and French
International Standard Serial Number: 0008-3984
Descriptors: animal industry periodicals.
NAL Call Number: 41.8 C163
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Journal of Animal Science* (American Society of Animal Science).
Place of Publication: United States, Wisconsin
Language: English
International Standard Serial Number: 0021-8812
Descriptors: livestock periodicals, animal culture periodicals.
NAL Call Number: 49 J82
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Journal of Dairy Science* (American Dairy Science Association).
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0022-0302
Descriptors: dairying periodicals.
NAL Call Number: 44.8 J822
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Poultry Science* (Poultry Science Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0032-5791
Descriptors: poultry periodicals.
NAL Call Number: 47.8 Am33p
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

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Mice and Rats

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.
NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: Q155.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Behavioral and Neural Biology*.
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0163-1047
Descriptors: animal behavior periodicals, neurobiology periodicals.
NAL Call Number: QH301.C63
Databases Indexed In: MEDLINE, BIOSIS, PASCAL, CAB ABSTRACTS

Title: *Behavioral Ecology and Sociobiology*.

Place of Publication: Germany

Language: English

International Standard Serial Number: 0340-5443

Descriptors: animal behavior periodicals, animal populations periodicals.

NAL Call Number: QL751.B4

Databases Indexed In: BIOSIS, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Behavioral Neuroscience* (American Psychological Association).

Place of Publication: United States, District of Columbia

Language: English

International Standard Serial Number: 0735-7044

Descriptors: neuropsychology periodicals, psychology, physiological periodicals, animal behavior periodicals.

NAL Call Number: QP351.B45

Databases Indexed In: PSYCINFO, BIOSIS, PASCAL, MEDLINE, AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Behavioural Brain Research*

Place of Publication: Amsterdam, Netherlands

Language: English

International Standard Serial Number: 0166-4328

Descriptors:

NLM Number: W1 BE135DE

Databases Indexed In: BIOSIS, PSYCINFO

Title: *Biology of Behaviour* (Centre National Recherche Scientifique).

Place of Publication: France

Language: in English or French; Summaries in Both Languages

International Standard Serial Number: 0397-7153

Descriptors: animal behavior, human behavior.

NAL Call Number: Q1750.B52

Databases Indexed In: BIOSIS, PASCAL, CAB ABSTRACTS, AGRIS

Title: *Developmental Psychobiology*.

Place of Publication: United States, New York

Language: English

International Standard Serial Number: 0012-1630

Descriptors: developmental psychobiology periodicals, psychobiology periodicals.

NAL Call Number: QP351.D4

Databases Indexed In: MEDLINE, BIOSIS, PSYCINFO, PASCAL

Title: *Ethology*

Place of Publication: Germany, Berlin

Language: English and German

International Standard Serial Number: 0179-1613

Descriptors: Animal-Behavior-Periodicals, Psychology,-Comparative-Periodicals

NAL Call Number: QL750.E74

Databases Indexed In: LIFE SCIENCES, BIOSIS, PSYCINFO, AGRICOLA

Title: *Journal of Comparative and Physiological Psychology* (American Psychological Association).

Place of Publication: United States, District of Columbia

Language: English

International Standard Serial Number: 0021-9940

NAL Call Number: 410 J822

Databases Indexed In: BIOSIS, MEDLINE, SOCIAL SCISEARCH, CAB ABSTRACTS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *Neuropharmacology*.
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0028-3908
Descriptors: neuropharmacology periodicals.
NAL Call Number: RM315.N4
Databases Indexed In: BIOSIS, PSYCINFO

Title: *Pharmacology, Biochemistry and Behavior*.
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0091-3057
Descriptors: pharmacology periodicals, biological chemistry periodicals, toxicology periodicals.
NAL Call Number: QP901.P4
Databases Indexed In: PSYCINFO, CAB ABSTRACTS

Title: *Physiology and Behavior*.
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0031-9384
Descriptors: physiology periodicals, psychology, physiological periodicals.
NAL Call Number: QP1.P4
Databases Indexed In: MEDLINE, PASCAL, SOCIAL SCISEARCH, PSYCINFO, CAB ABSTRACTS

Title: *Psychological Record*
Country of Publication: United States, OH
Language: English
International Standard Serial Number: 0033-2933
Descriptors: psychology periodicals
NLM Number: W1 PS632
Databases Indexed In: PSYCINFO, SOCIAL SCISEARCH, BIOSIS

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Subscription Information for Selected Publications

Animal Ethics Update

A quarterly newsletter for members of animal care and ethics committees published by the Animal Research Review Panel and the Animal Welfare Unit, New South Wales Agriculture, Australia. This publication contains a variety of information on animal welfare topics and practical suggestions for environmental enrichment programs. For information contact Rebecca Larkin, Editor, Animal Welfare Unit, NSW Agriculture, Locked Bag 21, Orange 2800, New South Wales, AUSTRALIA. Tel: (063) 91 3670, Fax: (063) 91 3570, e-mail: larkinr@agric.nsw.gov.au

Animal Keepers' Forum

Monthly journal of the American Association of Zoo Keepers, Inc. contains a regular feature--"Enrichment Options"--which highlights psychological stimulation, behavioral enrichment, activity manipulation, and occupational husbandry in zoo and aquarium environments. Subscription information can be obtained at 635 S.W. Gage Blvd., Topeka, KS (Kansas) 66606-2066 USA. Tel: 1-800-242-4519, Fax: (913) 273-1980.

Animal Technology

A journal published three times a year by the Institute of Animal Technology. Routinely features short articles, technical notes, or reviews pertaining to enriched housing/caging options or enrichment strategies for various laboratory and farm animals including birds and other non-mammalian species. G.E. Ward, Editor, School of Molecular and Medical Biosciences, University of Wales College of Cardiff, P.O. Box 911, Cardiff, Wales CF1 1ST, UK.

Animal Welfare

Quarterly journal produced by Universities Federation for Animal Welfare. "Brings together the results of scientific research and technical studies related to the welfare of animals kept on farms, in laboratories, as companions, in zoos or managed in the wild." Often includes enrichment articles. Subscription information can be obtained from UFAW, 8 Hamilton Close, South Mimms, Potters Bar, Herts, England EN6 3QD, UK. Tel: 01707 658202, Fax: 01707 649279.

Applied Animal Behaviour Science

This journal deals with the behaviour of domesticated and utilized animals. The principal subjects include farm animals (including poultry) and companion animals. Other species covered include rabbits and fur-bearing animals, deer, and animals in forms of confinement such as zoos, safari parks, and other forms of display. Laboratory animals are occasionally included. Requests regarding subscriptions may be sent to Elsevier Science B.V., Journal Department, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS. Tel: 31-20-4853642, Fax: 31-20-4853598. In the USA and Canada, write to Elsevier Science Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY (New York) 10010, USA. Tel: (212) 633-3750, Fax: (212) 633-3764, Telex: 420-643 AEP UI.

Guide to the Care and Use of Experimental Animals Volume 1, 2nd edition

Published by the Canadian Council on Animal Care in 1993. This publication contains a 40 page section on the social and behavioral requirements of experimental animals including wildlife kept in a laboratory setting. Other sections discuss facilities, the physical environment, occupational health and safety, surgical standards, control of pain, anesthesia, euthanasia, and guidelines for the use of animals in neuroscience research. To obtain a copy of this guide, write to Canadian Council on Animal Care, 1000-151 Slater Street, Ottawa, Ontario K1P 5H3, CANADA.

Lab Animal

This journal is published 11 times a year and emphasizes proper management and care of laboratory animals. It routinely contains articles dealing with environmental enrichment techniques and occasionally devotes an issue to the topic. Last issue of the year is the next year's *Lab Animals Buyers Guide*. Send subscription orders to *Lab Animal* Subscriptions Department, P.O. Box 1710, Riverton, NJ (New Jersey) 08077-7310 USA, Tel: (212) 726-9200.

Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare

The official journal of the Laboratory Animal Science Association, Gesellschaft für Versuchstierkunde, Nederlandse Vereniging voor Proefdierkunde, Schweizerische Gesellschaft für Versuchstierkunde, and the Federation of European Laboratory Animal Science Associations. A quarterly publication devoted to the "advancement of public education in laboratory animal science, technology, and welfare.... The Editorial Board wishes to give especial encouragement to papers describing work which... represents a significant refinement in methodology, leading to improvements in the welfare or well-being of the animals used." Subscription orders should be sent to Publications Subscription Department, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Articles should be sent to Editorial Manager, *Laboratory Animals*, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Tel: 071-290-2923.

The Shape of Enrichment

A quarterly bulletin featuring ideas for environmental and behavioral enrichment written mostly by zoo and aquarium researchers, keepers, and trainers. Topics covered include design and evaluation of enrichment devices and programs.

To subscribe write to *The Shape of Enrichment*, 1650 Minden Dr., San Diego, CA (California) 92111-7124 USA. Tel: (619) 231-1515, ext. 4272 or (619) 279-4273, Fax: (619) 279-4208.

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[[Journal Listing](#)] [[Subscription Information for Selected Publications](#)] [[Organizations](#)] [[Suppliers and Products](#)]
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[The Animal Welfare Information Center](#)

[U.S. Department of Agriculture](#)

[Agricultural Research Service](#)

[National Agricultural Library](#)

10301 Baltimore Ave.

Beltsville, MD 20705-2351

Phone: (301) 504-6212

FAX: (301) 504-7125

E-mail: awic@nal.usda.gov

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August 11, 1998

This page's URL is <http://www.nal.usda.gov/awic/pubs/enrich/journals.htm>

Organizations

"Organizations" is a chapter from: Smith, C.P. and V. Taylor (September 1995). [Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents](#). *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 227-236.

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

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North American Resources

- [American Association for Laboratory Animal Science \(AALAS\)](#)
- [American Society of Laboratory Animal Practitioners](#)
- [Animal Welfare Information Center \(AWIC\)](#)
- [Canadian Association for Laboratory Animal Science](#)
[L'Association Canadienne Pour La Technologies des Animaux de Laboratoire](#)
- [Canadian Council on Animal Care \(CCAC\)](#)
- [Institute of Laboratory Animal Resources \(ILAR\)](#)
- [National Library of Medicine \(NLM\)](#)
- [Scientists Center for Animal Welfare \(SCAW\)](#)
- [The Shape of Enrichment Video Library](#)

European, Asian, and Australian Resources

- [Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited \(ANZCCART\)](#)
 - [British Laboratory Animals Veterinary Association](#)
 - [Federation of European Laboratory Animal Science Associations \(FELASA\)](#)
 - [Gesellschaft für Versuchstierkunde](#)
Society for Laboratory Animal Science (GV-SOLAS)
 - [Institute of Animal Technology](#)
 - [Institut für Labortierkunde der Universität Zürich](#)
Institute of Laboratory Animal Science
 - [Japanese Association for Laboratory Animal Science \(JALAS\)](#)
 - [Laboratory Animal Science Assoc. \(LASA\)](#)
 - [Nederlandse Vereniging voor Proefdierkunde \(NVP\)](#)
 - [Scandinavian Federation for Laboratory Animal Science](#)
 - [Schweizerische Gesellschaft für Versuchstierkunde \(SGV\)](#)
Société Suisse pour la Science des Animaux de Laboratoire
Swiss Laboratory Animal Science Association
 - [Universities Federation for Animal Welfare](#)
-

North American Resources:

American Association for Laboratory Animal Science (AALAS)

70 Timber Creek Drive
Cordova, TN (Tennessee) 38018, USA

TELEPHONE: (901) 754-8620

FAX: (901) 753-0046

E-MAIL: info@aalas.org

WORLD WIDE WEB: <http://www.aalas.org>

CONTACT: Michael Sondag, Executive Director

TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional

RESOURCES/SERVICES: International in scope. Serves as a clearinghouse for collection and exchange of information on all phases of laboratory animal care and management, use and procurement of laboratory animals used in biomedical research. Educational materials, guides, and audiovisuals. Hold annual meetings that have workshops or seminars on environmental enrichment. Publish *Contemporary Topics* - a bimonthly journal with an expanded peer reviewed section on topics such as clinical management and husbandry. Also publish *Laboratory Animal* - a monthly, peer reviewed journal covering a diverse array of applied and experimental topics in the laboratory animal sciences.

REQUESTOR: Anyone.

COSTS: Charge for materials (members are charged a lower rate).

American Society of Laboratory Animal Practitioners

University of Texas Medical School
6431 Fannin Street, Room 1132
Houston, TX (Texas) 77030, USA

TELEPHONE: (713) 792-5127

FAX: (713) 792-5127

E-MAIL: bgoodwin@admin4.hsc.uth.tmc.edu

CONTACT: Bradford S. Goodwin, Jr., Secretary-Treasurer

TYPE OF INSTITUTION/ORGANIZATION: Private group of veterinarians

RESOURCES/SERVICES: Personal knowledge of veterinarians.

REQUESTOR: Anyone.

COSTS: None.

Animal Welfare Information Center (AWIC)

Agricultural Research Service
National Agricultural Library
10301 Baltimore Boulevard
Beltsville, MD (Maryland) 20705, USA

TELEPHONE: (301) 504-6212

FAX: (301) 504-7125

E-MAIL: awic@nal.usda.gov

WORLD WIDE WEB: <http://www.nal.usda.gov/awic>

CONTACT: Jean Larson, Coordinator

TYPE OF INSTITUTION/ORGANIZATION: Public, non-profit, government agency

RESOURCES/SERVICES: Vast collection of serials, monographs, and audiovisuals within the National Agricultural Library (NAL). Documents may be borrowed through an interlibrary loan. For more information on document delivery, contact (301) 504-5755. The Center performs brief complimentary searches of AGRICOLA and other relevant databases. The Center can also assist you in formulating your own database searches, provides conference facilities and

host training sessions, and can make available speakers and/or a tabletop exhibit for training sessions, conferences, and workshops. The Center produces bibliographies on topics such as stress, analgesia, animal testing alternatives, training materials and other relevant topics to animal welfare. Publishes the *Animal Welfare Information Center Newsletter*.

REQUESTOR: Anyone.

COSTS: All publications are available for free; literature searches on a cost recovery basis; NAL may charge for certain services such as providing photocopies, document delivery, etc.

Canadian Association for Laboratory Animal Science
L'Association Canadienne Pour La Technologies des Animaux de Laboratoire
c/o CALAS National Office
Biosciences Animal Service
University of Alberta
Edmonton, Alberta T6G 2E9, CANADA

TELEPHONE: (403) 492-5193

FAX: (403) 492-7257

E-MAIL: dmckay@gpu.srv.ualberta.ca

CONTACT: Donald McKay

TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional

RESOURCES/SERVICES: Produces educational materials, videos, and a monthly newsletter (CALAS/ACTAL Newsletter). Hold annual meetings with workshops, seminars, and poster sessions.

REQUESTOR: Laboratory animal professionals.

COSTS: Vary according to materials.

Canadian Council on Animal Care (CCAC)
350 Albert Street, Suite 315
Ottawa, Ontario K1R 1B1, CANADA

TELEPHONE: (613) 238-4031

FAX: (613) 238-2837

E-MAIL: lroach@bart.ccac.ca

CONTACT: Dr. James Wong, Director of Assessments

TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit

RESOURCES/SERVICES: Establishment and enforcement of standards and guidelines (in Canada) concerning the use of animals in research, testing and teaching. Maintain 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). Within these two documents the subject of environmental enrichment is addressed. 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. The Council addresses alternative methods and conducts a course on tissue culture. Semi-annually publishes the newsletter, *Resource*.

REQUESTOR: Anyone.

COSTS: Vary according to materials.

Institute of Laboratory Animal Resources (ILAR)
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. (District of Columbia) 20418, USA

TELEPHONE: (202) 334-2590

FAX: (202) 334-1687

E-MAIL: twolfle@nas.edu

CONTACT: Tom Wolfe

TYPE OF INSTITUTION/ORGANIZATION: ILAR is a unit of the National Research Council's (NRC) Commission on Life Sciences (CLS). The NRC is the working arm of the National Academy of Sciences (NAS), a private, non-governmental, non-profit organization.

RESOURCES/SERVICES: Information on a wide variety of topics related to laboratory animals and emerging adjuncts and alternatives to animal use. Assignments of genetic identification for unique colonies. Guidelines that assist in the implementation of national policies or laws. Information to teachers and students about animals in science and careers in biology. ILAR's information database, which is published as *Animals for Research: A Directory of Sources*. This assists scientists in locating specific animals and models, including nonhuman primates. Produce *ILAR NEWS* - a quarterly journal, available free-of-charge to institutional animal care and use committees, scientists, and veterinarians. Reports specific to nonhuman primates such as *Laboratory Animal Management: Nonhuman Primates*. A study on the well-being of nonhuman primates is currently underway by an ILAR committee. Manage *Animal Models and Genetic Stocks Information Exchange Program*.

REQUESTOR: Anyone.

COSTS: Vary according to materials.

National Library of Medicine (NLM)

8600 Rockville Pike

Bethesda, Maryland 20894, USA

TELEPHONE: (301) 496-6095 or 1-800-272-4787

FAX: (301) 402-1384

E-MAIL: ref@nlm.nih.gov

WORLD WIDE WEB: <http://www.nlm.nih.gov/>

TYPE OF INSTITUTION/ORGANIZATION: Public

RESOURCES/SERVICES: Library - extensive collection of serials, monographs, audiovisuals can be accessed by anyone. Computer based systems of information retrieval include MEDLARS, MEDLINE, CANCERLIT, AVLINE, TOXLINE, and Grateful Med.

REQUESTOR: Anyone.

COSTS: \$7.00 for each filled interlibrary loan.

Scientists Center for Animal Welfare (SCAW)

Golden Triangle Building One

7833 Walker Drive, Suite 340

Greenbelt, Maryland 20770, USA

TELEPHONE: (301) 345-3500

FAX: (301) 345-3503

CONTACT: Lee Krulisch, Executive Director

TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit

RESOURCES/SERVICES: Publications, including conference proceedings, training manuals, and materials from other organizations. Publications - *Canine Research Environment* and *Well-Being of Nonhuman Primates in Research*. Each contains proceedings from conferences sponsored by SCAW.

REQUESTOR: Anyone.

COSTS: Some services are free, others are fee-for-services basis.

The Shape of Enrichment, Inc.

1650 Minden Dr.

San Diego, CA 92111-7124, USA

E-MAIL: shape@enrichment.org

WORLD WIDE WEB: <http://www.enrichment.org/>

TYPE OF INSTITUTION/ORGANIZATION: Volunteer, non-profit.

RESOURCES/SERVICES: Loans videos of environmental enrichment programs currently in place in different zoos, aquariums, etc. around the country. Videos cover a variety of animals. **Donations of videos are encouraged.**

European, Asian, and Australian Resources:

Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)

P.O. Box 19
Glen Osmond SA 5064
AUSTRALIA

P.O. Box 598
5064 Wellington
NEW ZEALAND

TELEPHONE: 61-08-303-7393 (Australia) 64-04-472-7421 (New Zealand)

FAX: 61-08-303-7113 (Australia) 64-04-473-1841 (New Zealand)

E-MAIL: anzccart@waite.adelaide.edu.au

WORLD WIDE WEB: <http://www.adelaide.edu.au/ANZCCART/>

CONTACT: R.M. Baker

TYPE OF INSTITUTION/ORGANIZATION: private, non-profit

RESOURCES/SERVICES: Quarterly newsletter, and other publications on euthanasia, animal care and use committees, wellbeing of research animals, alternatives for undergraduate education, laboratory animal surveys, tumour cell lines available in Australia, humane care and use of animals in research, and animal pain.

REQUESTOR: Anyone.

COSTS: Vary according to materials.

British Laboratory Animals Veterinary Association

Honorary Secretary
C/O Site Services Department
Zeneca Pharmaceuticals
Mereside, Alderly Park
Macclesfield, Cheshire SK10 4TG, UK

TELEPHONE: 01625 513536

FAX: 01625 583074

CONTACT: D. Whitaker, Honorary Secretary

TYPE OF INSTITUTION/ORGANIZATION: Professional

RESOURCES/SERVICES: Slide programs on lab animal diseases, training materials, speakers notes and slides (eg., surgery and anaesthesia), and access to expert advice.

REQUESTOR: Veterinary surgeons with interests in laboratory animal health and welfare.

COSTS: None.

Federation of European Laboratory Animal Science Associations (FELASA)

BCM Box 2989
London WC1N 3XX, UK

CONTACT: P. Hardy, Secretary

TYPE OF INSTITUTION/ORGANIZATION: Professional

RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare*. Sponsors annual animal welfare symposiums.

REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Gesellschaft für Versuchstierkunde
Society for Laboratory Animal Science (GV-SOLAS)
C/O Institut für Versuchstierkunde
Pauwelstrasse, D-52074 Aachen
GERMANY

CONTACT: C. Herweg, Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare*.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Institute of Animal Technology
c/o University of Liverpool
Faculty of Medicine
Biomedical Services
P.O. Box 147
Liverpool, England L69 3BX, UK

CONTACT: P.A. Hynes, Honorary Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Publishes the quarterly journal *Animal Technology* and the monthly *Bulletin of the Institute of Animal Technology* (Phil Ruddock, Editor, 5 South Parade, Summertown, Oxford OX2 7JL, UK; Tel: 01737 247666). Videos and training manuals on humane care and handling, information on animal welfare.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Institut für Labortierkunde der Universität Zürich
Institute of Laboratory Animal Science
University of Zurich
Winterthurerstrasse 190
8057 Zurich, SWITZERLAND

TELEPHONE: 01 257 11 11 or 01 257 54 51
FAX: 01 257 57 03
CONTACT: Prof. Dr. med. vet. Peter E. Thomann, Director
WORLD WIDE WEB: <http://www.unizh.ch/labtier/>
TYPE OF INSTITUTION/ORGANIZATION: University
RESOURCES/SERVICES: Provides classes and training courses for technicians, students and postgraduates. Breeds rats and mice, offers diagnostic services for rodents and rabbits, offers in vitro production of monoclonal antibodies, and operates a consulting service to answer questions relating to the care of laboratory animals. Most information on Web site is in German.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Japanese Association for Laboratory Animal Science (JALAS)

2-8-10 Iwamotocho
Chiyoda-ku
Tokyo 101, JAPAN

TELEPHONE/ FAX: 03-3865-1475

RESOURCES: Publishes the quarterly journal *Experimental Animals*.

COSTS: Price of one issue is 2,500 yen (US \$25) for non-member individual.

Laboratory Animal Science Assoc. (LASA)

P.O. Box 3993
Tamworth, Staffs B78 3QU, UK

TELEPHONE: 01827 260036

FAX: 01827 260036

CONTACT: B.R. Howard, Honorary Secretary

RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare*.

Nederlandse Vereniging voor Proefdierkunde (NVP)

Dutch Association for Laboratory Animal Science

C/O Agricultural University Wageningen
CKP, P.O. Box 8129, 6700 EV
Wageningen, THE NETHERLANDS

CONTACT: F.A.R. van den Brock, Secretary

TYPE OF ORGANIZATION: Professional

RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare*.

Scandinavian Federation for Laboratory Animal Science

Enheten för försöksdjursvetenskap och service

Medicinska Forskningsrådet
Box 7151
S-103 88 Stockholm, SWEDEN

TELEPHONE: +46 8454 4281/77

FAX: +46 8454 4303

CONTACT: Barbro Salomonsson

TYPE OF INSTITUTION/ORGANIZATION: Professional

RESOURCES: Publishes the quarterly journal *Scandinavian Journal of Laboratory Animal Science*. Conducts annual meetings and publishes conference papers and abstracts in its journal.

COSTS: Journal subscriptions are Dkr. 250/individual; library subscriptions are Dkr. 600 + postage.

Schweizerische Gesellschaft für Versuchstierkunde (SGV)

Société Suisse pour la Science des Animaux de Laboratoire

Swiss Laboratory Animal Science Association

c/o RCC Registration and Consulting Co.
Landstrasse 33
4452 Itingen, SWITZERLAND

CONTACT: Ludwig G. Ullmann, Secretary or Dr. Marianne Geiser Kamber, President (e-mail: geiser@ana.unibe.ch)

WORLD WIDE WEB: WORLD WIDE WEB: <http://www.unizh.ch/labtier/>

RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals*, an international journal devoted to issues surrounding the care and use of laboratory animals. Sponsors seminars and conferences and publishes the resulting papers and abstracts.

REQUESTOR: Laboratory animal users.

COSTS: Vary according to material.

Universities Federation for Animal Welfare

8 Hamilton Close
South Mimms, Potters Bar,
Hertfordshire, EN6 3QD, UK

TELEPHONE: 01707-658202

FAX: 01707-649279

E-MAIL: trevor.poole@ucl.ac.uk

CONTACT: Victoria Taylor, Development Officer

TYPE OF INSTITUTION/ORGANIZATION: Private, charitable

RESOURCES/SERVICES: Publications, reprints, videos, educational brochures, and advisory services. Publishes a quarterly scientific journal entitled *Animal Welfare*, which brings together information from zoos, laboratories, farms, wild, and companion animals.

REQUESTOR: Anyone.

COSTS: Vary according to materials. Annual subscriptions to the journal *Animal Welfare* cost £50/US\$100.

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Suppliers and Products

"Suppliers and Products" is a chapter from: Smith, C.P. and V. Taylor (September 1995). [Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents](#). *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 237-242.

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

The following links access AWIC and other chapters in this publication:

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Agri-Engineering, Inc. 2600 College Avenue, Goshen, IN (Indiana) 46526, USA. Tel: (219) 533-0497 or (800) 447-2751 (USA only).

Manufacturer of Plastic Piggy Playballs.

Ancare Corp. 2647 Grand Ave., P.O. Box 814, Bellmore, NY (New York) 11710-0814, USA. Tel: (800) 645-6379, Fax: (516) 781-4937.

Supplier of Nestlets, a rodent nesting material.

B & K Universal Ltd. The Field Station, Grimston Aldborough Hull, North Humberside HU11 4QE, UK. Tel: 01964 527555, Fax: 01964 527006.

Product line includes:

- disposable cardboard tubes for smaller mammals
- wooden chew blocks for rabbits and guinea pigs
- Beekay Litterite bedding
- different shaped food treats for primates

Big Dutchman International GmbH. P.O. Box 1163, D-49360 Vechta, GERMANY. Tel: +49 4447 8010, Fax: +49 4447 801237.

Manufacturer of Gather-all Breeder Nest System that is designed to safely handle eggs from the bird to the collection belt while providing comfort to the hen.

Bio-Serv. P.O. Box 450, Frenchtown, NJ (New Jersey) 08825, USA. Tel: (800) 473-2155, Fax: (800) 473-2167.

Manufacturer or distributor of a variety of environmental enrichment products for dogs, swine, rabbits, and primates.

Product line includes:

- **Dogs**
 - Pen Pals which are treats developed to enhance socialization programs
 - Certified Rawhide Bone is designed for toxicology labs performing strict diet studies. The bone is assayed and chemically screened to ensure it is 100 percent rawhide. The bone helps control tartar and serves as an enrichment tool.
 - distributor for Kong toys for dogs

- **Swine**

- Oinkers which are treats developed to reduce stress associated with handling and other procedures
- P.R.A.N.G. which is an oral rehydrator useful in post-operative care
- distributor of Kong toys for swine

- **Rabbits**

- Rabbit Stix which are treats containing papain to help prevent hairballs
- distributor of Kong toys for rabbits

Booda Products, Inc. 26707 Agoura Road, Suite 110, Calabasas, CA (California) 91302, USA. Tel: (818) 878-3900, Fax: (818) 878-3909.

Makers of a variety of toys for dogs, cats, and birds. Product line includes:

- **Dogs**

- rope tugs with different attached objects for chewing and pulling provide for dental health
- Booda Velvets which are chew toys made from corn-derived products

- **Cats**

- rope toys
- scratching posts and mats
- cat furniture
- litter boxes

- **Birds**

- perches for all cage sizes

Boomer Ball. 24171 West Route 120, Grayslake, IL (Illinois) 60030, USA. Tel: (703) 546-6125 or (800) 858-9529.

Makers of non-toxic, heavy-duty, polyethylene plastic balls, mazes, ice floes and other devices. For use with small mammals to large carnivores and apes.

Product line includes:

- Boomer Ball--intended for soccer-style play, to encourage healthful exercise as an alternative to destructive chewing, pacing, and other undesirable behaviors. The ball has a rigid sidewall which is resistant, but not impervious, to chewing and scratching. The roughened surface on a used ball may be smoothed with a carpenter's rasp, file, or rough sandpaper. The ball is hollow, and the 10 inch and 20 inch diameter balls have a screw-out plug which allows insertion of pebbles, bells, etc. to produce an enticing noise, or sand or water to add weight.
- Ferret and Small Animal Ball--a 10" diameter ball for use in cages for chinchillas, guinea pigs, ferrets, and hedgehogs. The ball provides a maze-like play area with plenty of ventilation if the animal chooses to sleep inside the ball.
- Ferret Hide "N" Seek Maze Logs--a 16" long, 4 ½ diameter log-shaped tube with 4" openings at each end and two 4" openings on the side. The units can be snapped together to form unlimited maze configurations for small animals, such as ferrets, chinchillas, and guinea pigs and other small rodents.
- Bobbins--a round, hollow, spool-shaped, heavy polyethylene play/exercise toy for larger breeds of dogs and exotic animals.

Braden Industries. P.O. Box 2010, Sulphur Springs, TX (Texas) 75483, USA. Tel: (903) 439-3233 or (800) 272-3361 (US only), Fax: (903) 439-1814.

Manufacturer of the Braden Start Dry Feed Bottle that allows calves to be weaned to dry feed by suckling a rubber nipple and receiving pelleted feed rather than liquid.

Britz-Heidbrink, Inc. P.O. Box 1179, Wheatland, WY (Wyoming) 82201-1179, USA. Tel: (307) 322-4040, Fax: (307) 322-4141.

Produces animal housing systems that include "enrichment panels" that use color, noise reduction, thermal neutral surfaces, and opportunities for animal exploration.

Eisers. 360 Kiwanis Boulevard, Hazelton, PA (Pennsylvania) 18201, USA. Tel: (800) 526-6987 (USA only) or (717) 450-6130, Fax: (800) 680-3926 (USA only) or (717) 455-1593.

Manufacturer and distributor of the Giant Stallmate Apple, a scented toy for horses and pigs, and the Equi-Ball, a toy for horses.

Ethical, Inc. 216 First Street, Newark, NJ (New Jersey) 07107, USA. Tel: (201) 484-1000.

Manufacturer of solid vinyl chew toys for dogs and Squish balls for cats.

Jansen Engineering and Construction Company. Mercuriusweg 25, 3771 NC Barneveld, THE NETHERLANDS. Tel: +31 3420 21020, Fax: +31 03420 21019.

Manufacturer of Jansen automatic roll-away nests for hens. The shape, color, and floor material of the nest have been chosen according to the latest research in bird behavior.

K.L.A.S.S. 4960 Almaden Expressway, Suite 233, San Jose, CA (California) 95118, USA. Tel: (408) 266-1235.

Distributor of environmental enrichment products including Kong Toys, Boomer Balls, Nylabone, mouse nesting box, and a variety of easily sanitized play objects for birds, cats, dogs, ferrets, pigs, and primates. Product line includes:

- **Birds** (all items made of acrylic)
 - rattles, swings, log 'n' chain, playing, hoops, chains, playhouse, mirrors, ladders and other toys
- **Cats**
 - Bizzy Kitty Home Entertainment Center
 - Sokker ball made of plastic
 - mini-Sox
 - Sparkel ball
- **Dogs, Pigs, and Primates**
 - Kong Toys in all varieties and shapes
 - Nylabone products such as plaque attacker dental ball, all sizes of nylabones, gumabones, nylarings, tug toys, rubber knots, and gumaballs.
- **Ferrets**
 - Ferret Ball

Landmeco A/S. DK-6870 Ølgod, DENMARK. Tel: +45 75 24 55 11, Fax: +45 75 24 43 53.

Manufacturer of the Landmeco Nest. Each roll-away nest contains six nest pads that provide the hens with a warm and comfortable laying area.

Wm. Lillico & Son (Wonham Mill) Ltd. Wonham Mill, Betchworth, Surrey, RH3 7AD, UK. Tel: 01737 247666, Fax: 01737 246783.

Produces a variety of forage mixes and is a distributor of Boomer Balls and the Scanbur A/S rabbit cage. Other products include:

- honey and sunflower rolls for rabbits
- paper wool for nesting, fine paper shavings for bedding or nesting, and Enviro-Dri which is a comfortable bedding designed specifically for large animals, canines, and primates.

P.J. Murphy Forest Products Corp. P.O. Box 300, 150 River Rd., Montville, NJ (New Jersey) 07045, USA. Tel: (201) 316-0800, Fax: (201) 316-9455.

Produces "Sani-Chips" animal bedding. Hardwood and softwood products are available.

Nylabone Products. Third Avenue and Union St, Neptune, NJ (New Jersey) 07753, USA. Tel: (908) 988-8400.

Manufacturer of Nylabone, Nylaballs, Gumabone Plaque Attacker, Gumabone tugs, and Gumadisc Flying Disc chew toys for dogs and other animals.

David Nunn Ltd. Station Yard, Hadnall, Shrewsbury, Shropshire SY4 3DD, UK. Tel: 0939 210555, Mobile: 0836 224691.

Distributors of Sundown Livestock Bedding and Environmental Straw Products. Poultry bedding is available in 25 kg poly-wrapped bales of de-dusted, sterilized straw.

R.J. Patchett, Ltd. Queensbury, Bradford, Yorkshire BD13 1DS, UK. Tel: 0274 882331, Fax: 0274 816362.

Manufacturer of laying cages with perch frames designed to meet EC welfare requirements. Also make nest boxes.

Primate Products. 1755 East Bayshore Rd., Suite 28A, Redwood City, CA (California) 94063, USA. Tel: (415) 368-0663, Fax: (415) 368-0665.

Produces "Kong Toys" which are autoclavable hollow toys that are durable enough to withstand rough handling and biting. They can also be filled with treats. Recommended for primates, canines, pigs, and rodents.

Rappa Fencing Ltd. Steepleton Hill, Stockbridge, Hampshire SO20 6JE, UK. Tel: 01264 810665, Fax: 01264 810079.

Manufacturer of eight- line electric fence system designed specifically for free range poultry.

Renco. Unit K1A, Bath Road Trading Estate, Stroud, Glos, England GL5 3QF, UK. Tel: 01453 752154, Fax: 01453 752155.

Manufacturer of electric netting for free range poultry. Offers protection from predators and provides bird control.

Scanbur A/S. Gl. Lellingegård, Bakkeleddet 9, Lellinge, DK-4600 Køge, DENMARK. Tel: +45 56 82 02 21 or 020 79 52 44 (Sweden only), Fax: +45 56 82 14 05.

Manufacturer of environmentally enriched caging systems for rabbits. Allows for single, pair, or group housing of rabbits. This cage system increases the possibility of exercise and physical activity. Rabbits can obtain social contact with fellow rabbits, and they can retire and hide whenever they want to. Each cage contains a resting shelf and shelter. Scandinavian distributor for Special Diet Services.

Shepherd Specialty Papers. P.O. Box 804, Kalamazoo, MI (Michigan) 49005, USA. Tel: (616) 324-3017 or (800) 382-5001(USA only) , Fax: (616) 324-3026 or (800) 222-5170 (USA only) .

Manufacturer of ALPHA-dri (alpha cellulose) which is a loose animal bedding of precisely defined composition. Also produce Enviro-Dri which is a bedding developed for pen-housed primates, large animals, and canines. Enviro-Dri is also recommended for the nesting of all animals.

Société Parisiennes des Sciures. 33, rue de Gode, 95100 Argenteuil, FRANCE. Tel: 39 80 15 09, Fax: 39 80 66 64, Telex: 688214 F.

Distributor of Litalabo bedding for laboratory animals.

Special Diet Services. P.O. Box 705, Witham, Essex, CM8 3AD, UK. Tel: 01376 511260, Fax: 01376 511247.

Manufacturers of diets in mixed shapes and sizes.

Tapvei. 73600 Kaavi, FINLAND. Tel: +358 71 688 88 99, Fax: +358 71 663 234.

Manufacturer of Tapvei bedding, bedding dispensers and waste removal systems, items for cage enrichment and Aspen bricks for dogs, rabbits, and rodents.

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Common Enrichment Devices and Programs

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 - [Dogs](#)
 - [Farm Animals: Cattle, Horses, Sheep and Goats, Swine](#)
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"Common Enrichment Devices and Programs" is a chapter from: Smith, C.P. and V. Taylor (September 1995). [Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents](#). *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 243-246.

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

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Birds

Balls (leather, rubber, plastic or tennis)
Cage space to allow wing flapping
Cocoa husks
Colored objects
Dustbaths
Foraging litter or substrate
Grain blocks
Litter
Mirrors
Music
Nest building material
Nest boxes
Operant feeders (singly housed birds)
Pecking targets
Perches
Pre-formed nests
Roll-away nest box
Roosting shelves
Shredded paper
Social groups
Straw substrate

Wood shavings

Cats

Balls

Bedding materials

Bells

Catnip toys

Climbing frames

Colony housing

Sheepskin mice

Perches

Climbing poles

Human interaction

Movable toys

Music

Puzzle boxes

Elevated resting spaces

Ropes

Scratching posts

Shelves

Social housing

Stuffed toys

Vertical space

Viewing panels

Dogs

Balls

Bedding

Bones

Chew toys

Exercise

Gumabone chews

Human interaction

Knotted cloth

Novel objects

Nylabone frisbees

Nylabones

Plastic decoys

Rawhide

Resting boards

Ropes

Socialization

Tug toys

Walks

Farm Animals

Cattle

Bedding
Fitting barriers
Human-Animal Interaction
Manipulable objects
Novel objects
Operant Food Devices
Social Housing

Horses

Foraging material
Grazing areas
Hanging Balls
Human-animal interaction
Novel objects
Social housing
Substrates (straw, wood shavings, etc.)

Sheep and Goats

Social or natural grouping
Bedding or substrate (straw)
Mirrors
Climbing structures (rocks or wood structures)

Swine

Balls
Bedding (straw, wood chips)
Chains
Edinburgh Football
Forage material (hay)
Free-range
Group housing
Heated floor mats
Hoses
Human-animal interaction
Knotted cloth
Manipulatable devices
Music
Novel objects
Plastic jugs
Pre-formed nests
Ropes
Scented plastic apples
Substrates (straw, wood chips, sand, etc)
Tires
Turn-around farrowing crate

Ferrets

Balls

- Bite cups
- Crickets
- Foraging devices
- Fur covered movable toys
- Hide-and-seek tunnels
- Mazes
- Moving prey-models
- Music
- Nest boxes
- Plastic burrows
- PVC tubes
- Shelters
- Swimming pans

Rabbits

- Balls
- Bedding (straw, wood chips)
- Burrows
- Free range
- Fresh fruits or vegetables
- Gnawing objects
- Group housing
- Hide-boxes
- Manipulatable objects (wood)
- Music
- Nest boxes
- Nesting material
- Pair housing (except adult males)
- PVC pipe
- Resting shelf
- Roughage or Forage (hay, straw)
- Varied diet

Rodents

- Bedding
- Burrows
- Cage dividers
- Climbing accessories
- Climbing frame
- Exercise devices (running wheels)
- Film canisters
- Foraging devices
- Funnel
- Gnaw blocks or sticks
- Group or social housing (not hamsters or adult males)
- Hide boxes
- Ladders
- Mazes
- Music
- Nest boxes or nest-building material - (hay, tissues, or wood-wool)

Platforms
PVC pipe
Ramps
Shelves
Shuttle box
Tubes
Tunnels

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Environmental Enrichment Information Resources for Laboratory Animals: Subject Index

Note:

The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *printed page number* on which the index term can be found. Although the page numbers referenced in this index refer to the original printed publication, the subject terms may be helpful when searching text in the electronic version. Each subhead also is linked to the chapter and bibliography related to that topic.

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- [Bird Bibliography](#), pages 5-26

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- [Environmental Enrichment in Rodents](#)
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- [Environmental Enrichment in Rodents](#)
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