

# Environmental Enrichment in Rodents

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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, conspecifics, 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 conspecifics 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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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.

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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.

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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. Klomp maker, 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.

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## ***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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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.

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NAL call number: 410 B63

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

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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'élevage 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. Burrigh, and P.J. Donovan (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. Burrigh, 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, <sup>3</sup>H-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. Garipey, 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 S<sub>1</sub>, 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 S<sub>1</sub>, 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, corncobs, 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, acitivity.

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 Psicologia* 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 S<sub>1</sub>, 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, [<sup>3</sup>H]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. Baker, 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/impoverished 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. Demircoren, 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 S<sub>1</sub>, 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 S<sub>1</sub>, 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 S<sub>1</sub>, 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.

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Descriptors: rat, female, protein kinase C, learning, memory, [<sup>3</sup>H]-PDBu, receptor binding, cortex, hippocampus, radial maze, environmental enrichment.
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Descriptors: rat, Long-Evans, hooded, male, social learning.
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Descriptors: rat, Long-Evans, male, dorsal hippocampus, brain weight, granule cells, plasticity.

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

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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.

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

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

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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.

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

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NAL call number: RC321.E96

Descriptors: rat, male, Berkeley S<sub>1</sub>, 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.

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Descriptors: rat, neonates, cortical dendrites, Golgi-Cox-Sholl stain.

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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*

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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 S<sub>1</sub>, 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 S<sub>1</sub>, 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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