Int. j. adv. multidisc. res. stud. 2022; 2(6):654-659

Received: 12-10-2022
Accepted: 22-11-2022

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Rodents and Rabbits Environmental Enrichment for Laboratory Rodents and Rabbits

Layla Abd-Al-Sattar Sadiq Laylani
Northern Technical University Kirkuk Technical Institute, Musul, Iraq

Corresponding Author: **Layla Abd-Al-Sattar Sadiq Laylani**

Abstract
Laboratory animals are sensitive beings, and environmental variables, such as housing and care, have a lasting impact on them throughout their lives, which may be seen in the data collected from animal experiments. However, the living arrangements of experimental animals are often founded on pragmatic and pleasant considerations. Giving lab animals the chance to engage in a repertoire of behaviors unique to their species is one potential strategy to enhance their quality of life. Animals need environmental enrichment as much as they need food and medical treatment, thus, it is important to include it as part of the whole care program. The animal crew is the most important part of an enrichment program, and they need to be inspired and knowledgeable. In order to determine if an enrichment is beneficial for the animal, it is important to analyze the animal's use of and preference for the enrichment, as well as the enrichment's effect on the animal's actions and how they affect physiological variables; a case study of species-typical behavior and performance. In addition, it is of the utmost importance to analyze the effect on scientific discoveries, the impact of enrichment on scientific research, and the impact on the statistical power. All three of these factors the measured parameter, the kind of enrichment used, and the specific animal strain will affect the result. The purpose of enrichment is defined and addressed in this article. The description of animal requirements and behaviors includes how those needs are transformed into environmental enrichment initiatives. A review of environmental enrichment is given, along with a description of specific forms of environmental enrichment using examples from the literature.

Keywords: Variation, Rodents, Rabbits, Housing, Environmental Enrichment, Animal Needs

1. Introduction
Environment factors like housing and care have a significant effect on lab animals throughout their lives and will thus affect the results of animal investigations. In spite of the fact that this often comes at the cost of the animals' well-being, however, economic and ergonomic issues are generally what drive the design of housing systems for laboratory animals (such as equipment, expenses, space, workload, capacity to view the animals, and ability to maintain a specific level of cleanliness). It is not often mentioned in the general upkeep of laboratory animals that they have distinct environmental needs based on their species. However, owing to variation in genetic background, the diversity in the particular demands differs not only across species but also within strains of a species [1].

2. Rodents and Rabbits' Behavioral Repertoire
The Laboratory rats and rabbits have made certain adaptations to living in captivity, but they nevertheless exhibit traits common to their wild counterparts. The animal's environment in the lab has to encourage natural behaviors including socializing, sleeping, constructing a nest, keeping a low profile, venturing out of the cage, exploring, eating, and chewing [2, 3]. For instance, since they are very vulnerable to predators, rats and rabbits are more prone to exhibit severe panic reactions when they are in new circumstances and are unable to locate refuge. This pattern of action involves trying to get away, biting when touched, and becoming completely still. In a perfect world, the animal would feel secure in a difficult but manageable setting.
Giving lab animals the chance to engage in a repertoire of behaviors unique to their species is one potential strategy to enhance their quality of life. Opportunities may arise because of environmental enrichment, which may be defined as any change made to an animal's habitat with the goal of improving the animal's physical and mental health by providing stimuli appropriate to the animal's species. Toys and social engagement are only two examples of environmental enrichment methods that may be

used to improve animals' quality of life. The behavior, physiology, and brain architecture of the animal may all be affected by environmental enrichment. As an example, shown that rats from richer settings performed better on the "Hebb-William's labyrinth." The ability to learn, the thickness and weight of the cortical layers, the size, quantity, and complexity of the brain connections, and the ratio of RNA to DNA have all been shown to improve in animals that are kept in enriched constrained settings. Therefore, environmental enrichment may be seen of as a method of conducting experiments on the brain and behavior [4, 5].

Environmental enrichment initiatives were first created at zoos to improve the surroundings of caged animals. European legislation currently mandates the use of environmental enrichment as a means of improving the lives of laboratory animals.

3. The Objectives of Environmental Enhancement

The purpose of environmental enrichment is to improve the quality of the animal's confined habitat so that the animal has more opportunities for entertainment and a greater say in both its social and physical surroundings. This can be accomplished by providing the animal with a greater degree of autonomy. The enrichment of animals should not put the health and safety of the persons who are responsible for the care of the animals, the animals themselves, or the research at risk by causing the animals to become injured or very hostile against one another. Prior to marketing and deployment, enrichment products should be scientifically examined and their designs should take into account behavioral demands as well as data from enrichment studies. The following crucial principles should serve as the foundation for the execution of certain environmental enrichment approaches:

- Enhancing the animal's capacity to handle difficulties.
- Increasing the use of environmental resources for good.
- Lowering the incidence of unusual behavior.
- Expanding behavioral variety.
- Enhancing the environment's quality so that the animal has more options for entertainment and some control over its social and physical surroundings in captivity.

Facilities for laboratory animal research have progressively included environmental enrichment. This rise seems to be a good thing from a welfare standpoint since it is well acknowledged that providing environmental enrichment increases the welfare of the animal [6, 7].

Animals that are deprived of the opportunities to engage in the behaviors that are typical of their species are more likely to exhibit indications of discomfort, such as aberrant patterns of behavior, persistent stress, or other pathological conditions. The growth and operation of the brain and behavioral processes are hampered by housing situations that are socially isolated, barren, and constrictive. Enhanced barbarization of dendrites in the brain has been seen in animals with brain damage and decreased motor performance who have been exposed to an enriched environment. Additionally, researchers have discovered genetic variations across mouse strains that were hidden by conventional laboratory upbringing when compared to enriched habitats.

4. Needs of Animals

Animals have behavioral and physiological demands. Physical requirements like food, water, and sleep should obviously also include some kind of shelter. Activities like as social behavior, exploration, foraging, grooming, digging, nest building, and shelter seeking are examples of the kinds of things that are important for sustaining a physiological and psychological state of health. Since rats and rabbits engage in these activities in the wild and in captivity, it is possible to consider them to be essential intrinsic behaviors.

Knowing and comprehending an animal's natural behavior is essential to determining their requirements and what they want in their surroundings. On the other hand, not all aspects of natural behavior or natural habitat are necessary or even desirable in a controlled laboratory situation. A great starting point is research on the habits of wild descendants of long-extinct laboratory rats. Nevertheless, it is widely acknowledged that environmental enrichment is advantageous for laboratory animals' wellbeing and that it should be used wherever suitable or feasible. Rather than striving to recreate natural behaviors in the lab, it is more important to construct the environment in such a way that natural behaviors may be exhibited and rewarded.

5. Environmental enrichment programs that include the needs of animals

Choice experiments that are thoughtfully planned may be used in conjunction with consumer-demand research to determine an animal's preference for a feature. These studies reveal the amount of "money" an animal is prepared to "spend" on the feature in question. This method provides a technique to arrange the requirements of the animal. Enrichment programs have to place a premium on fostering highly driven activities including social interaction, foraging, nest building, and exploration [8, 9].

The animal crew is the most important part of an enrichment program, and they need to be inspired, knowledgeable, and given the authority to carry out the program. Specialists in addition to the participation of animal careers and researchers.

The importance of enrichment should be considered on par with that of veterinarian treatment and nutrition in the entire animal care program. To simplify the process of acceptance by researchers, animal caretakers, and management, as well as to standardize the methodology, every choice that pertains to enrichment should be included into the standard operating procedures of the institution. Additionally, data should be maintained in records and/or databases to facilitate the introduction and assessment of various enrichment kinds.

6. Various Environmental Enrichment Methods

An effective program that helps both the animals and the results of the experiment should be included in environmental enrichment. It should not include applying things at random that personnel believe the animals would find appealing. Below is a description of the many enrichment categories, which are often divided into social and physical enrichment.

Social Development

Animals may be socialized with conspecifics, contra specifics, including humans, while in touch or without contact (referred to as "noncontact"). The corresponding descriptions are included below.

Enhancing social interactions

Conspecific pairs or groups should be employed to house gregarious species. If possible, littermates should be kept together, although given the size of the groups and potential for bias in the research, this arrangement may not always be feasible. Nonetheless, the group dynamic should be stable and cordial, even if it must offer obvious obstacles or hiding spots to prevent violence. Even in well-adjusted groups, it is important to provide people the opportunity to initiate contact by coming closer to one another or to avoid touch by moving out of sight.

A social companion is the most difficult enrichment component for social animals. When compared to static enrichment items that are only interesting for certain activities, a social companion constantly presents the animal with novel and surprising scenarios to which they must respond. In stable, harmonic communities, having a social partner increases attentiveness and exploratory activity while also offering amusement, employment, and maybe even some sense of "security."

When compared to rats who are maintained alone, rats that are housed in groups display stress responses less often and for shorter durations. According to a decision made by the Council of Europe regarding the housing and care of experimental animals, group housing, or even pair housing, is preferred to solo housing for any gregarious species that typically expresses social behavior. This is the case so long as the groups are stable and harmonious. The Guide for the Care and Use of Laboratory Animals provides essential suggestions for the care of animals, including the encouragement of behaviors that are characteristic of the species and the reduction of those that are caused by stress. This reality gives rise, rather often, to the need that social animals be housed in appropriate pairs or groups. In conclusion, interaction with humans typically results in improvements not only for the animals but also for the findings of research. This is because interaction with humans engages the animal on a cognitive level and promotes positive involvement with animal caretakers, technicians, and researchers.

Social Enrichment Through Distance

Social noncontact enrichment includes encounters with conspecifics or contra specifics via the senses of sight, sound, and smell. According to a resolution made by the Council of Europe about the housing and wellbeing of experimental animals, it should be taken into consideration to house conspecifics in close proximity to one another in terms of sight, sound, or smell [10, 11]. When communal living conditions are not possible. It should be emphasized, too, that when animals are subjected to these stimuli without a way out, this method may be disagreeable to them.

Enrichment of the body

Complex enclosures and stimulation for the senses and the body are all parts of physical enrichment. The list of these sources of enrichment is briefly detailed below.

Complexity

Although providing a greater floor area is often preferable to appropriately structuring the cage/pen environment, a structured space must have at least a minimal floor area. Animals do not truly utilize space for anything other than locomotion (such as playing); instead, they make use of the resources and structures nearby to carry out certain activities. The majority of rodents and rabbits make an effort to segregate the places in their homes where they sleep, eat, and excrete. Light levels are only one aspect of the animals' environment that may be modified with the help of the partitions. Such partitions may be simplified by cage-insert structures.

It has been shown that giving mice and rats nesting materials improves their ability to reproduce (also see below). There have been several research that suggest supplying nesting material may increase the number of pups that survive and decrease preweaning mortality. Nesting material did not influence breeding outcomes, according to at least one research.

Material for Nests

Small rodents such as mice, hamsters, gerbils, rats, and so on. Mice, rats, hamsters, and gerbils all require nesting material to create comfortable, fertile little homes (Figure 1). It is just as crucial to provide rats with nesting boxes or other hiding spots.

Pigs in cages. Cursorily rodents like guinea pigs do not burrow; instead, they may dwell in animal-made burrows in the wild. Nesting boxes, tubes, and other concealing spaces should be included in the cage or enclosure so that the animals have somewhere to go when they feel threatened. Hay may be used to satisfy the animal's need for roughage, and wooden sticks can be used to satisfy its urge to chew and gnaw.

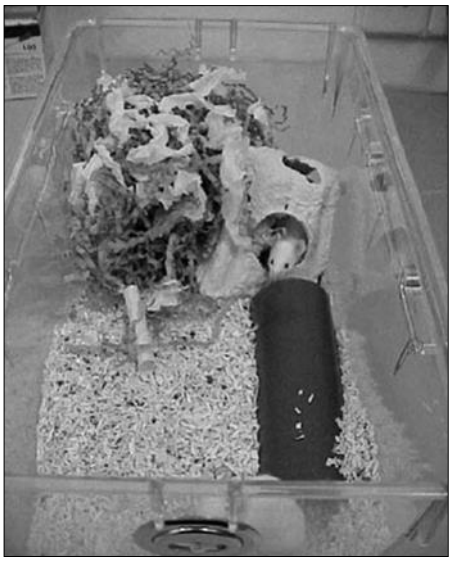

Fig 1: An example of enriching the habitat for mice. a picture taken by M. K. Meijer

Gerbils: Are known for their enormous tunnel networks in the wild, and if given the right conditions, they will often exhibit stereotypical digging activity in the lab. Because gerbils require a burrow option in addition to a thick layer of litter that is at least 20 centimeters in length for digging and nesting, they have a greater need for a much greater amount of area in which to construct or use tunnels of an appropriate size. Animals for the purpose of chewing and gnawing may use nesting materials, such as hay or straw, as well as pieces of wood.

Hamsters: The hamster's ancestors in the wild spent most of their time alone. It is possible to raise animals in groups;

however, considerable care should be taken to form groups that are socially amicable, and aggressive animals, particularly females, should be kept apart. Nesting materials, a refuge location roughage, and chewing toys should be a minimum need for enrichment.

Rabbits: In terms of rabbit enrichment, hay blocks or chew sticks are the basic minimum, in addition to a refuge and observation area (e.g., a platform). Breeding does should have access to nesting materials, a nest box, or another safe haven. It is recommended that group housing floor pens have visible obstacles (Figure 2).

Nesting materials are used by more than only reproducing species. Mice in the lab are known to quickly use nesting items and participate in nest-building activity, as well as spend between 10%-20% of their waking hours interacting with nesting materials. Animals can benefit from toys in the development of exploratory behavior, locomotor's function, and visual performance. Animals play as a means of honing the survival-related behavioral abilities. Toys, however, only hold our attention for a short while—usually just one day. Some toys, such those that can be eaten or used as a nest, are more likely to be played with for an extended amount of time, but even regular toy changes may keep a child's curiosity alive.

Sensory stimulation

Visual, aural, olfactory, tactile, and taste stimulation are all a part of sensory enrichment. Contact with other members of their own or a different species, either face-to-face or via bars, is one of the most pleasurable types of enrichment for rats and rabbits. This type of interaction may take place face-to-face or through the bars. In contrast to primates, it has been shown that providing albino mice with enrichment in the form of mirrors in their cages is beneficial. Consistent background noise (such as radio music playing at 85 dB loudness) throughout the day has been theorized to have some benefits for boosting breeding and reducing animal excitability by dampening the startle effect of sudden stimuli. New age music was found to have a substantially more relaxing impact on mice than classical music, pop music, or no music at all, according to the findings of a research that compared the effects of several types of music on mice. Even with music playing in the background, the loud noise continued to have an unsettling effect on the mice and caused them to demonstrate the disturbance response. However, the daily usage of radios in institutions for animals may be advantageous to the employees, which in turn may help the animals.

Fig 2: A rabbit-enriched house example. Danish company Novo Nordisk A/S took the photo

Institutions that keep experimental animals have to clean the cages on a regular basis, but doing so might disrupt the social order of the animals and lead to an increase in aggression, particularly among male mice. Aggression may be affected in a number of ways by olfactory cues from nesting and bedding materials. While sawdust containing urine or excrement increased hostility, the transfer of nesting material decreased antagonism. Taste stimulation might be achieved by offering the animals different meals (such as carrots for rabbits and seeds for rats) (see Nutritional Enrichment below). This strategy, meanwhile, could conflict with GLP1 standards for good laboratory practice. By giving animals the chance to dig, nesting material, and shelter, tactile stimulation may be achieved.

Nutritional augmentation

Animals are often extremely motivated to employ enrichment that involves food. Such information was found in the reports of several studies. Furthermore, it is crucial to remember that GLP regulations could call for a description and evaluation of the items utilized.

Animals respond differently based on schedule and frequency. In contrast to the morning feeding schedule, which Krohn and colleagues (1999) found to promote conventional rabbit behavior, evening feedings considerably reduced sexism in the species. Since foraging takes up a lot of an animal's time in the wild, supplying food and letting the animal forage appear to prevent boredom, even if the food may be contaminated by the animal's own waste if it does not have the capacity to compartmentalize its environment. According to, animals will continue to actively look for food even if it is easily accessible. This is because the process of actively searching for food offers information about the proximity and quality of possible foraging areas. Additional feeding items such as hay, straw, or grass cubes are possible ways to fulfill the requirements of roughage and chewing that guinea pigs and rabbits have. Sticks made of soft wood are a favorite food of rodents and rabbits. Aspen blocks are chewed on by rats, particularly when they are confined without bedding. Hamsters should have food pellets within their cages since they often stockpile food.

A review of the enrichment

Exploration and animals' reactions to novelty are influenced by factors including genotype, age, sex, individual variance, and overall housing circumstances. When additional material (such paper or wood) is introduced to an animal cage as environmental enrichment, the animal and the experiment may also be affected. For instance, it has been shown that the animals are impacted by the volatile chemicals in bedding and enrichment materials.

Reduced variations between studies (intra experimental variation) improves the repeatability of findings across labs, and reduced differences between animal groups (intra experimental variation) makes it easier to identify treatment effects. However, studies have shown that despite extensive efforts to standardize conditions across sites, distinct inbred mouse strains studied that were born at the same time in three reputable facilities showed significant impacts from their individual locations for virtually all characteristics examined.

It is important to evaluate the benefits of environmental enrichment based on factors such as the animal's use and preference of a particular enrichment, the effect on behavior,

the performance of species-typical behavior, and the effect on physiological parameters because of the reasons that have been stated above. Additionally, it is essential to investigate whether or not enrichment has an effect on the advancement of scientific breakthroughs. It is also vital to do an analysis to determine whether or not the statistical power is changed, and if it is, how. Depending on the kind of enrichment that is carried out, the power of an experiment and the size of its sample population may either be raised, decreased, or maintained at the same level.

As the capacity of an animal to successfully adapt to its environment is the definition of animal welfare, it follows that animals raised in enriched environments may be better able to adjust to changes in their surroundings, such as those that occur between the breeder and the animal facility or during experimental procedures. This is because enriched environments provide animals with more opportunities for mental and physical stimulation. The refining idea put out by Russell and Burch receives support from these findings as a consequence (1959). In addition, research has shown that animals that are provided with enrichment react less adversely to stressful experimental settings; as a result, one may anticipate a less degree of variation in the results. This would be in line with the reduction principle that Russell and Burch argue for, which calls for the use of fewer animals in scientific research. Animals housed in better conditions are likely to have more physiological and mental stability; this suggests that they may serve as better models for scientific research). When a species' environmental demands are not met, reliable results cannot be obtained. Mice reared in richer environments exhibit a broader spectrum of activities and show much less stress.

Despite these promising results, some researchers worry that animals housed in enriched environments would behave more inconsistently to experiments than those housed in standard facilities. Worryingly, this trait may raise both the data' inherent unpredictability and the number of animals subjected to experimentation. The ultimate aim of any study using animals is to eliminate or greatly reduce any and all sources of error in order to get data that can be trusted. But if the animal was healthy and showed no indications of stress throughout the trial, then the possible variance brought on by environmental enrichment may be a good thing since it would signal that more natural behavior is seen. Additionally, previous research has demonstrated that enrichment does not always produce more varied outcomes. Mice's physiological and behavioral responses to their nesting material are unchanged, and mice having access to objects and nesting material acclimated more quickly to open field testing without changing their circadian behavioral patterns. Anxiety-reducing medications had a greater effect on mice and hamsters kept in enriched surroundings, according to many pharmacological studies. Turner *et al*. found no evidence of immunosuppression in rabbits kept in groups (1997). Numerous studies on the impact of enrichment on experimental outcomes have pointed out that, despite the advantages that enrichment offers for the animals, it is crucial to consider specific parameters, such as the sort of enrichment and the animal strain.

It follows that enrichment may either amplify, dampen, or have no influence on variability, depending on the measure being examined. How different mouse strains respond to enrichment has been a topic of discussion amongst researchers. Focusing on the specific requirements of each animal and implementing simple enrichment is preferable to using a sophisticated cage, which is utilized in neuroscience to elicit changes in the brain and the capacity for learning and memory. It's vital to correctly define the sort of enrichment in the Materials and Methods section of scientific articles to ensure the reproducibility of experimental results. Because only then will the experiment's controls and variables be able to be identified and quantified with any degree of accuracy.

7. Conclusion

The responsibility to enhance the standard of the confined environment is on those who utilize and care for experimental animals. Approaches to enrichment must be well thought out and presented in order to achieve this. Even if enrichment causes the experimental study's variety to rise, it is crucial to balance this variation against the animals' overall enhanced well-being rather than overstating it. More information is required to assess the effects of animal enrichment programs on the animals themselves, on the variety of species, strains, and models used in experiments, and on the results of those experiments. These results need to be based on the methods created and used by effective enrichment programs.

Several genetically modified rat strains will likely remain indispensable to scientific research for the foreseeable future. Since it is evident that a universal method for enrichment is not going to work for every species, we can probably assume that not all rat strains will respond well to the same approach. Scientists are asked to gather, record, and distribute vital data in order to refute misunderstandings and uncover differences associated to environmental enrichment.

8. References

1. Künzel, Frank, Anja Joachim. Encephalitozoonosis in rabbits. Parasitology Research. 2010; 106(2):299-309.
2. Vennen, Kristine M, Mark Mitchell A. Rabbits. Manual of exotic pet practice. WB Saunders, 2009, 375-405.
3. Bosze ZS, Houdebine LM. Application of rabbits in biomedical research: A review. World Rabbit Science. 2006; 14(1).
4. Orr, Robert T. The rabbits of California. San Francisco: California academy of sciences, 1940.
5. Liu SJ, *et al.* A new viral disease in rabbits. Animal Husbandry and Veterinary Medicine (Xumu yu Shouyi). 1984; 16(6):253-255.
6. Mykytowycz, Roman. Territorial marking by rabbits. Scientific American. 1968; 218(5):116-129.
7. Okerman, Lieve. Diseases of domestic rabbits. Blackwell Scientific Publications, 1988.
8. Quesenberry, Katherine E, James W. Carpenter. Ferrets, rabbits and rodents. Elsevier, 1997.
9. Spörl E, *et al*. Studies on the stabilization of the cornea in rabbits. Der Ophthalmologe: Zeitschrift der Deutschen Ophthalmologischen Gesellschaft. 2000; 97(3):203-206.
10. Fernández-Carmona J, *et al*. Recommendations and guidelines for applied nutrition experiments in rabbits. World Rabbit Science. 2005; 13(4):209-228.
11. Douzery, Emmanuel JP, Dorothée Huchon. Rabbits, if anything, are likely Glires. Molecular Phylogenetics and Evolution. 2004; 33(3):922-935.

12. Hewitt CD, *et al*. Normal biochemical and hematological values in New Zealand white rabbits. Clinical chemistry. 1989; 35(8):1777-1779.
13. Carneiro, Miguel, *et al*. The genetic structure of domestic rabbits. Molecular biology and evolution. 2011; 28(6):1801-1816.
14. Blomstedt, Patric, *et al*. Dittmarand the History of Stereotaxy; Orrats, Rabbits, And References. Neurosurgery. 2007; 60(1):198-202.
15. Glatt, Herbert, Robert Machemer. Experimental subretinal hemorrhage in rabbits. American journal of ophthalmology. 1982; 94(6):762-773.