

Module 06 - Environmental Enrichment

The objectives of this module are:

- To introduce the reader to the concept of environmental enrichment.
- To discuss the elements involved in environmental enrichment
- To place the effects of environmental enrichment within the research effort
- To provide examples of environmental enrichment

Introduction

Much of our knowledge on the effects of environmental enrichment comes from studies on rats and mice. The most common source of information comes from our observation of the wild counterparts to our domestic and laboratory animals. We recognize that wild animals have certain behaviours that are commonly performed. All young animals run and jump and play and this is important for the development of strong muscles and bones, for good coordination, and for developing social skills and relationships. They also learn discipline from adults and young animals that get out of line are likely to be punished. Wild animals of all ages must deal with both threats and deprivations (e.g., predators, parasites, a lack of food or a poorly balanced diet, poor shelter against miserable weather, excessive cold or heat, etc.). Laboratory animals are sheltered from these problems but are they better off?

Experimental animals were traditionally kept in caging which provided little or no social or physical stimulation. The use of such caging was justified on the basis of reduction of disease spread, ease of sanitation, prevention of fights between animals, easy recognition of illness through measuring food and water intake, etc. However, at the time, little consideration was given to the behavioural and psychological well-being or the stress induced by social isolation and physical deprivation. It is recognized now, that the well-being of animals is greatly improved if they are provided with opportunities for interaction with each other and their environment. Furthermore, there is an increasing volume of literature denoting the deleterious effects of impoverished environments on experimental results.

Although the term "environmental enrichment" is used to describe efforts aimed at improving the living conditions for animals, the move is really from a very impoverished environment to a less impoverished environment. It is unlikely that the level of complexities encountered by wild counterparts will ever be achieved within the laboratory. Furthermore, it is possible that the wellbeing of an animal will not be increased by our ideas of increased complexity in its environment. Nevertheless, the wild species are often taken as the norm against which the environment of the captive animal is measured. Some argue that the wild and laboratory animals are no longer the same behaviourally, but most wild behaviours are seen in the laboratory animal. The presence of a normal range of behaviours and the absence of abnormal behaviours or stereotypes is a reasonable indication that the animal is coping with its environment. To make such judgements, we must be able to recognize normal and abnormal behaviours. Those species that are prey animals in nature, seldom reveal that they are hurting in any way as this would be an invitation for predation. Another approach to evaluating well-being is to use the Five Freedoms of the UK Farm Animal Welfare Council. These freedoms were defined to give guidance to farmers on the goals of husbandry. However, the freedoms are easily adapted to other animals and have been accepted by various groups including the World Veterinary Association and Humane Societies.

The five freedoms are:

1. freedom from hunger and thirst (by ready access to fresh water and a diet to maintain full health and vigour)
2. freedom from discomfort (by providing an appropriate environment including shelter and a comfortable resting area)
3. freedom from pain, injury and disease (by prevention or rapid diagnosis and treatment)
4. freedom to express normal behaviour (by providing sufficient space, proper facilities and company of the animal's own kind)
5. freedom from fear and distress (by ensuring conditions and treatment which avoid mental suffering)

The freedoms are general enough to allow them to be used for any animal species and to allow for interpretation related to particular species. They must be applied carefully with an

understanding of the biology of each species and care must be taken to avoid using our own ideas as animal standards.

Terms like "discomfort" make us think about the animal's living conditions and while we tend to think of the extremes of heat and cold, or wet and dry, there are grades of discomfort in between the extremes as we know from our own experience. A cool room is uncomfortable if we do not wear enough clothes and a hairless animal without any means of building a nest or others to huddle with may be uncomfortable at the normally recommended temperatures in the animal facility.

We can assume, given our present knowledge, that the health, nutrition and general environment needs of the common laboratory animal species are being met in present day laboratory animal facilities. The major challenge for us is to provide them with social and physical opportunities to live and behave in a normal manner. To do that we must have some knowledge of what a particular animal needs based on understanding their preferences. All animals require social interactions although for some this interaction is intermittent and occurs only at breeding times. Most wild animals occupy their days in the search for food and water. The threat of predation is a fact of life for many small animals, including those in the laboratory where we are the predators. To be frightened without having any means of protecting yourself is a stressful experience. Lack of space or structure to exercise or play, in the case of young animals, is detrimental to bone and muscle development and maintenance.

The major factors to be considered then are:

- Opportunities to socialize or not
- Opportunities to occupy time during waking hours
- Opportunities to hide
- Opportunities and structure for exercise

Opportunities to Socialize or Not

Totally isolated animals are known to be different from group-housed animals. This is seen even with pet animals like dogs. But not all animals want to live together and it may be undesirable to have groups with both sexes present. Aggression may be a problem with some species and strains but this may be reduced or prevented if the environment is sufficiently

complex. Sight barriers may be enough to break aggressive activities within a group. There should be the possibility for an animal in a group to socialize or not. This is often difficult to arrange in a small cage but even a small cage may be broken up into separate areas. For example, the use of small igloos in a mouse cage allows some to be in the igloo and some outside.



Opportunities to Occupy Time During Waking Hours

Searching for food, gathering nesting materials, play, travel, exploration, etc., are all activities that help pass the time. The environment of many cages does not allow much of this to occur. The highly nutritious food provided allows animals to consume their daily needs with very little effort. While commercially available foods are processed to contain all the elements that an animal requires, they may be low in palatability and certainly in variety. It is possible to vary the diet for most experimental animals without imposing yet another variable on the study by providing small amounts of treats. These treats provide additional tactile, olfactory, and taste stimuli. Cage equipment, nesting material, etc., allows the animal to interact with and in some cases manipulate their environment. The equipment or material in the cage should be appropriate for the animal's behavioural needs. Perches for birds, for example, should be the correct size or in a variety of sizes so that the birds can pick the most comfortable one for them. Animals are sometimes given toys to play with but the toys should have some relevance to the animal or it will soon be neglected. Some animals, e.g., rats, may not like new toys, especially if they have no apparent function for the animal and the toy may be buried. The unpredictability of another animal may provide the majority of the diversion required to prevent the development of stereotypes that often develop when there is nothing to do. Rats have been shown to work harder to gain access to another rat than to gain access to their favourite toy. Exploratory behaviour is an important component of the daily routine for many young animals, particularly rodents. This activity is often studied in rats and it is recognized that there are clear behavioural differences

between rats that have had the opportunity to explore, for example, in a complex environment and those that have been reared in a simple environment. Rats that have been reared in the standard rat cage will stand up and look out when the top is removed. They will rarely attempt to leave the cage. On the other hand, rats that have lived in a complex environment will take the opportunity to explore the room if the cage is left open.

Opportunities to Hide

Most laboratory animals appreciate a place to hide, whether it be from cage mates, people or unexpected noises. Even within gregarious species, individuals may require a place to get away. Thus, where possible, animals should have a place within the cage where they feel safe. This may be a dark corner or it may be a sight barrier (e.g. tubes, overturned containers), which allows them to look for the cause of their alarm without revealing themselves. Disputes among animals often end when the "chasee" gets out of the sight of the chaser. Unexpected noises are common in animal facilities and may be startling to animals. The natural tendency for the prey species is to hide while they try to determine the source of the noise. Large human figures peering into cages may also be frightening, causing the animals to seek refuge. If there is nowhere safe to hide, the animals will be stressed.

Opportunities and Structure for Exercise

Space for exercise is important, particularly in young animals. Animals like to run or hop and this is important for bone and muscle development. Space alone is usually not enough as can be seen in the pacing of some large cats in zoos. There should be structures within the space to allow climbing, stretching, swinging, etc. Even relatively small structures within a cage will be used for exploration. Mice are often seen clinging upside-down to the food hopper.

Environmental Enrichment and Research Results

Improving the environment is not just a nicety for research animals. There is a considerable body of literature now that demonstrates the influence of an animal's physical and social environment on research results. One of the earlier demonstrations showed that social and physical stimulation of rats resulted in a thicker cerebral cortex with more dendritic connections.

Tumours in isolated mice grow faster than the same tumours in mice housed at appropriate densities. Isolation of mice has been shown to increase the toxic effects of some drugs.

It has also been shown that environmental enrichment is beneficial at any stage of an animal's life. The effects may be different between young and old animals but the old will also benefit. For this reason it is important to consider environmental enrichment as a variable in an experiment and to account for it. It is not an option, however, to omit environmental enrichment to reduce the variables in a study unless the investigator is prepared to include all the deleterious effects of an impoverished environment on the study. Even then, it would be difficult to say that the results represent the normal state of the animal. However, if an investigator feels that attempts at environmental enrichment will jeopardise the results of a study, then this should be justified to the Animal Care Committee. Environmental enrichment encompasses more than just the physical and social environment of a group of animals. Because we interact with them at various levels, we may have a profound effect on their life. We should treat animals in a manner that minimizes any discomfort or stress they may experience at our hands. All the environmental enrichment in the world will not be of any value if an animal fears the arrival of a human being at its cage. It may not be just the presence of a person but it may also include the sounds and smells associated with an experimental procedure, for example. Our activities in the animal facility may be disturbing, even if they do not directly involve the animals. Noise is disturbing to animals and we should minimise extraneous noises as much as possible. Some people bustle and have an air of urgency about them that is unsettling to animals. Doors are allowed to slam shut or objects fall on the floor. Equipment like cage washers, vacuums etc. may be upsetting, particularly to pregnant animals. If we try to see things as the animals might see them, we will probably be able to improve their living conditions. In return, people working with the animals, particularly the animal care technicians, feel better about their jobs when they see the animals responding to their enriched environment. It must be emphasised that changing an animal's environment, whether it be giving it a clean cage devoid of familiar "homey" smells or adding toys or other objects for enrichment, will be a variable that should be accounted for. It is important, then, not to make changes to the environment without the agreement of the principal investigator and if changes are made, they should be applied consistently to all animals in the study. It should be remembered that there may be effects of withdrawing enrichment, for

example, if the animals move from a facility with very complex environments to one where there is minimal complexity.

Examples of Environmental Enrichment (General)

There follows a series of examples of enriched environments for animals. The form of enrichment provided for a species should take into account the normal environment for that species and how the species interacts with its environment. It is not necessary, or even generally feasible, to duplicate exactly the natural environment but the substitutes should allow the animal to perform as many of its natural behaviours as possible. Further examples of environmental enrichment may be found in the literature. Comfortable Quarters for Laboratory Animals. Eds. Viktor and Annie Reinhardt may be accessed via the Internet at

<http://www.awionline.org/pubs/cq02/cqindex.html>.

The CCAC publication "Guide to the Care and Use of Experimental Animals Vol.1 2nd edition, has a section on the Social and Behavioural Requirements of Experimental Animals (Chapter VI) and it can be found on the CCAC website. An extended list of references may be found on the CCAC website at www.ccac.ca

Examples of Environmental Enrichment (Mice)



Even a simple glass bottle will provide variation in the environment for a mouse in a small cage. In this case, the mouse and her offspring are using the bottle as a nesting spot. In some cases, the mice use the bottle as a urinal, thereby keeping the rest of the cage dry and clean. If this happens, the bottles must be changed frequently. Mice will not use it once there is a significant amount of urine in the bottle and will block up the entrance.

A divider in the cage like the one shown below allows the mouse to use different "rooms" for different purposes. In this case one of the small rooms has been selected for the nest. It is important to provide mice with nesting materials so that they can construct a suitable nest. This does not just apply to breeding mice as male mice will also build nests. The nesting material is given in the large "room" and the mice select where they will build the nest. Most select one of the smaller rooms.



Examples of Environmental Enrichment (Rats)

This blue Plexiglas structure (above) was introduced into a large bin approximately 100cm X 160 cm, to provide the rats with something to play on and to exercise in. There were 20 rats each weighing about 200g in the bin. The above picture was taken one morning when most of the rats were resting. There are twenty rats in the picture and the space where most are resting was about 1000 cm². (The CCAC recommended minimum space for a single rat greater than 150 g is 250 cm².) Rats do not mind lying on top of each other but they need space to do other things. Crowding occurs when the space is so limited that the animals cannot get away from each other and this is stressful.



This is the same structure as in the previous picture. The picture was taken within a few minutes of the structure being turned upright. The rats demonstrated two behaviours that we

should try to accommodate. They wanted to hide under something and they wanted to explore. Rats, particularly young rats will make use of any structure in their cage to play, explore, hide etc. It is not necessary to provide something that would be present in their natural environment.

Examples of Environmental Enrichment (Birds)

Chickens, quail, ducks, and turkeys, and other birds are often used in research. There is sometimes a conflict between the commercial housing of birds, particularly chickens, quail, ducks and turkeys, and the research housing of the same birds. It is common for investigators to invoke the need to do research using the same housing conditions that are used in the industry so that the results of the research will be applicable. Many of the industry standards for the housing of these birds are under review, both from within the industry and among the public that purchase the product. For example, many members of the public are concerned by the battery system of housing hens to produce eggs and there have been many attempts in recent years to move away to more bird-friendly housing (e.g., free range systems and aviaries). There is a need, too, in research institutions to provide modified, enriched environments for birds to avoid the demonstrably stressful housing used by the industry.

Not all birds need space to fly but the provision of aviaries or flight cages for research pigeons helps maintain their health. Most birds like to peck and scratch in dirt, looking for food to eat. It is said that chickens will spend up to 50% of the day looking for food in this manner. In addition, they consume a much wider variety of foods than those kept in small cages with a processed diet brought to the cage. Most birds engage in dust or water bathing and this is an important component of their maintenance behaviour. Most birds perch and so they should be given the opportunity to perch.



Other Animals - Fish, Reptiles and Amphibians

Fish, amphibians, and reptiles are common research animals. Although there has been little research done on these animals in terms of environmental enrichment, there is considerable information on their husbandry in captivity and on their behaviour in the wild. It is reasonable to try to provide these animals with some form of environmental enrichment. This will vary widely among the species. Small fish, for example, may benefit from having places to hide, even if predation is not a threat in an aquarium with only one species. Hiding places may be "caves" on the bottom or plants growing in the water. The unpredictable movements of plants, even artificial plants, may provide stimulation and novelty to the fish. It may be necessary to cover some sides of aquaria so that the fish are not being continuously startled by the sight or shadow of large humans passing by. Reptiles and amphibians have specific requirements depending on the species. As cold-blooded animals they are somewhat more dependent on their physical environment to meet their needs. It is important to design the environments to meet the requirements of the animal, based on observation of wild animals. If group housing is used, then issues of territoriality, hierarchy, etc. must be considered. Many reptiles require different temperatures depending on their activity so cooler refuges should be available within the environment. Amphibians and reptiles need places to hide. Climbing animals should have things to climb on. Animals that spend time in the water in the wild should be able to do so in the laboratory. The guide is to try to provide the right conditions for the animals to fulfill most of their major behavioural activities.

Summary.

In the past, animals were kept in cages or pens that provided very little substrate for them to engage in many of their natural behaviours. Environmental enrichment is a phrase used to cover a wide range of additions or modifications of the environment to allow animals a more varied life. Although many of the changes are indeed to the physical environment, changes in social opportunities for the animals are also important; and social opportunities include interactions with people. A major benefit of environmental enrichment is the reduction in stress in the animals with beneficial influences on the research projects they are involved in.