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This issue of the *BRL Bulletin* discusses environmental enrichment of laboratory animals, including how enrichment enhances animal well-being, a brief discussion of governmental regulations and oversight, and enrichment strategies developed for the species housed in the BRL.

Environmental enrichment is a combination of strategies designed to promote the psychological well-being of animals housed in laboratory settings. These include social, structural, sensory, and nutritive components that encourage animals to display normal behaviors. Thus, enrichment programs are tailored to address species-specific needs. Before implementing enrichment, a thorough analysis is conducted to ensure novel items are species appropriate, safe, and easily sanitized.

Environmental Enrichment: Effects on Animal Welfare and Research

Our understanding of the psychological well-being of animals is constantly evolving as more is learned about species-specific behavior. An effective enrichment program provides for an animal's cognitive and physical needs by emulating the complexity of the natural environment. The addition of meaningful, species-appropriate enrichment benefits both the animals as well as the research community.

The use of environmental enrichment in laboratory animal facilities often stimulates conflicting opinions as to its value. On the one hand, the literature is abundant with examples of the positive effects enrichment has on animals' welfare. On the other hand, there are studies illustrating the unpredictable impacts enrichment may have on research, such as introducing confounding variables. As both views hold truths, it is crucial that enrichment be implemented only after careful analysis. If chosen hastily enrichment has the potential to negatively affect the welfare of the animals as well as the research[1].

Appropriately enriched environments should provide animals the perception of control over the microenvironment, which allows them to better cope with external stressors. The ability to react to adverse stimuli in a natural manner reduces stereotypical or abnormal behaviors which otherwise can have detrimental effects on both animal health and research validity. Animal's housed in unenriched environments can develop physiological, neurological, immunological, and behavioral abnormalities, which are not only a welfare concern, but raise questions regarding the validity of research results[2]. Therefore, creating species tailored enrichment programs while avoiding one-size-fits-all plans enhances animal well-being and works to reduce inter-experimental variability, therefore creating better animal models for scientific purposes[3,4,5,6].

Designing an Enrichment Program: Rules and Regulations

Designing a successful enrichment program requires a collaborative effort from the veterinary staff, ACC, and research community. Many factors are considered during the enrichment planning process, such as ensuring that the objectives set forth by the U.S. Department of Agriculture's (USDA) Animal Welfare Act (AWA), the *Guide for the Care and Use of Laboratory Animals* (*Guide),* and the ACC are met[7, 8]. Various components of the BRL enrichment program are reviewed annually by the USDA, as well as triennially during AAALAC accreditation site visits, to ensure compliance with AWA standards and the recommendations of the *Guide.*

The AWA requires the inclusion of exercise time for single housed dogs while also recognizing the importance of positive interactions with humans as a means of enhancing animal well-being. The AWA's criterion for nonhuman primate enrichment focuses on social housing to address their psychological needs as well as addition of meaningful manipulanda to their environment.

The *Guide* expands on the AWA by providing recommendations for all vertebrate species. The emphasis is on social housing for social species as it is considered to be central to the promotion of psychological well-being. It recommends that the structures and resources used for enrichment purposes facilitate the expression of species typical behaviors and provide sensory and motor

stimulation. Similar to the AWA standards for dogs, the *Guide* also promotes the benefits of positive human contact for all species to facilitate handling.

The AWA and the *Guide* place the responsibility of describing and implementing species-specific enrichment plans on each institution. This allows flexibility and creativity in designing programs that meet the institution's management and research needs. Occasionally, specific research protocols may seek to opt out of certain aspects of the enrichment program. These situations are the exception and not the rule. Any request for an animal to be exempt from the enrichment program must be justified scientifically and is subject to ACC approval. Moreover, the enrichment program is reviewed semiannually by the ACC and veterinary staff to ensure that the program meets regulatory and industrial standards while providing beneficial outcomes.

Species-Specific Enrichment: BRL Enrichment Program

Enrichment is not simply the addition of toys or edible treats to an animal's enclosure, but is rather the integration of various methods to stimulate natural behaviors, with an emphasis on group or pair housing social species. At the BRL we have a dedicated enrichment technician, who works meticulously to ensure that appropriate enrichment is provided to all our species, with particular importance placed on ensuring that canine and swine social needs are met. A second technician spends three days a week focusing on social housing of nonhuman primates through behavioral assessments in order to find compatible mates. Here we discuss species-specific enrichment that promotes cognitive and motor activity, sensory stimulation, and social housing for laboratory animals at UIC.

Mice

With the exception of certain strains, mice are social animals that demonstrate altruistic behaviors such as group care of neonates and thermoregulation through huddling. It is important to emphasize that although social housing encourages natural behaviors, space requirements restrict how many animals can be grouped together. Additionally, although they are social, mixing adult males from different litters frequently results in fighting, and can have detrimental outcomes on both the health of the mice and to research objectives. Non-social enrichment, such as providing nesting material, is an equally essential aspect of mouse-specific enrichment programs. Nest building is an activity utilized not only by dams to protect their litters, but is central to many behaviors in mice. In the wild, mice build nests for shelter and as protection from predators and the elements. Nesting material also provides a level of control over the animal's microenvironment and helps contribute to their psychological well-being. Provision of inanimate objects, such as marbles, elicit digging and burying action, a behavior associated with anxiety in mice[9]. Such behaviors have no biological relevance and since the items do not allow control over the animal's environment, they serve no purpose and exemplify inappropriate enrichment for this species.

Rats

Rats are very social rodents. Juveniles are often observed partaking in play behaviors, such as roughhousing and tickling. Adults remain equally social and greatly benefit both physiologically and psychologically from pair or group housing, as well as positive human contact. As for non-social enrichment, preference studies show that rats choose items they can gnaw over nesting material. In the wild, rats do not build nests, and so providing such substrate would be ineffective and species-inappropriate. Instead, at the BRL, rats are provided with wooden tongue depressors, which are inexpensive, safe, and can be sterilized. The tongue depressors allow the rats to wear down incisors, promoting the expression of a natural behavior and providing a health benefit. Due to study requirements that restrict the use of tongue depressors, rats at the BSB facility receive plastic tubes that they utilize as a hiding place or climbing structure.

Guinea pigs

Guinea pigs can be social, and when possible, they are pair housed at the BRL. In the wild, they require liberal space and resources to discourage fighting. It is therefore important to focus efforts on non-social enrichment such as cage furniture that provides protection and a sense of security. At the BRL cardboard tubes or modified rat cages with elevated platforms offer the animals a place to hide.

Rabbits

Wild rabbits are social animals that live in large groups when ample space and resources are available. Adult rabbits, however, have a high propensity to fight when space is limited. Therefore they are usually single housed in the laboratory setting, exemplifying why it is important to know the natural behaviors of each species. Emphasis on non-social enrichment is core to the rabbit enrichment program at the BRL. Rabbits are very inquisitive creatures, and benefit from having a

variety of toys for gnawing and playing. Providing food enrichment such as sweet potatoes, carrots, and hay are not only part of a healthy diet, but provide new scents, tastes, and textures.

Dogs

Dogs used in research have been selected and bred to be amenable, non-aggressive, and easily handled by humans. Positive human interaction, toys, exercise, and group housing are central to an appropriate enrichment program. Sufficient space is also a core aspect, which is regulated by the AWA. At the BRL, dogs are given at least two times the minimum floor space required by the AWA standards. In addition to ample housing space, dogs are provided weekly supervised group exercise time, where they are allowed time to express their natural behaviors such as running, exploring, and playing with other dogs. At the BRL, staff frequently groom, train, pet, and socialize the dogs. The social aspect of the canine enrichment program is emphasized, as it not only helps prevent anxiety, but also aids in acclimation to handling for research manipulations. Other strategies used in the canine enrichment program include pair housing when possible, rotation of toys, and provision of highly palatable food treats.

Pigs

Juvenile pigs, such as those commonly used in research, are highly social animals, and therefore benefit from group housing. The BRL's behavioral technician works with these intelligent animals to acclimate them to common husbandry and research related procedures, which provides cognitive stimulation and further socialization. Non-social enrichment should not be overlooked when devising a plan for these clever and curious animals. At the BRL, pigs are housed on bedding that allows them to root, a behavior seen in wild pigs, where they explore their environments by pushing their snouts in the dirt. To further encourage rooting, pigs are given durable plastic balls and toys that can be manipulated with their snouts. Pigs are highly food motivated and receive rotating novel foods, such as root vegetables and fruit. You may also see the bristle end of a broom hung in the pens, which allows self-scratching and adds a layer of choice and control to their immediate environment.

Nonhuman primates

Old World nonhuman primates live in large social groups in the wild and divide the majority of their time between grooming and foraging for food. To mimic these activities in captivity, while also engaging these highly intelligent species cognitively, primate enrichment programs are often quite complex. First and foremost, the *Guide* emphasizes the importance of social housing of primates. Studies show that pair or group housed primates have a much lower incidence of stereotypies, and have lower levels of cortisol which contribute to faster wound repair times and shortened postoperative recovery periods[10, 11]. The primate enrichment team at the BRL works diligently to establish compatible pairs, dedicating many personnel hours to assessing individual personalities prior to initiating a carefully monitored introduction process. On occasion, previously successful pairs may develop aggression towards one another over time. These animals are not exempt from social housing, but rather, our dedicated technicians start the process over to find new compatible cage mates. In the situation where social housing is not possible, indirect contact, through the use of grooming bars or mesh dividers are utilized to allow compatible animals the opportunity to engage in social contact.

Non-social enrichment is an important aspect of primate enrichment plans and encompasses strategies that stimulate the senses and encourage physical and cognitive activities. At the BRL, durable plastic toys are rotated through the cages at regular intervals and are utilized by the primates in a variety of ways, such as swinging, throwing, and chewing. To encourage foraging, seed mixes are provided three times a week in PCV pipes hung outside the cages, allowing the animals to sift through, and pick out preferred items. On days when seed forage is not provided, the primates are given novel fruits and vegetables to supplement their regular biscuit diet. To evoke auditory stimulation, all primate rooms are equipped with speakers allowing a variety of nature sounds or soft music to be played daily during work hours. A favorite element for both the animals and the BRL staff is popcorn day. Popcorn is popped in the animal room, providing auditory, visual, and olfactory enrichment. The popcorn is then distributed to all primates as a novel food item. Often, popcorn day coincides with the weekly viewing of an animated movie, which is played on a portable TV in the animal rooms. This unique enrichment encompasses many aspects of the goals set forth by the environmental enrichment program at the BRL.

Aquatic species

There are currently few guidelines on environmental enrichment for aquatic laboratory species. However, as ethological studies provide new data, enrichment programs are continuously

advancing. For instance, studies suggest that providing barriers, such as synthetic grass, in zebrafish tanks may increase the health of subordinate males[12]. Without protection, these males may be chased to exhaustion by more dominant fish, a point to be considered as our zebrafish colony expands.

Environmental enrichment programs are central to improving the care of laboratory animals. In particular, social housing is emphasized as a critical component to animal well-being. Enriched animals are often better experimental models for human disease, therefore having direct beneficial impacts on research studies. For more information or questions, please contact a member of the veterinary staff, or visit the BRL website.

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ANNOUNCEMENTS

We had a very successful AAALAC site visit. The site visit team indicated in their exit briefing that they would recommend that the UIC animal care and use program receive continued full accreditation. The site visit team also recognized what they saw to be a very positive and collaborative relationship between the UIC research community and the veterinary and IACUC staff. On behalf of the institution, the BRL veterinary staff would like to thank all research staff who use animals in their research for helping us prepare for the site visit. Your assistance in getting your animal colonies and laboratories ready for a successful site visit is deeply appreciated.