Enrichment Strategies
for
Rodents in the Laboratory

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This document provides a brief overview of the current literature with respect to the provision and impact of environmental enrichment on laboratory rats and mice. The development of enrichment programs for non-regulated species, e.g., rats, mice, birds, and other laboratory animals, continues to receive attention from the scientific community. A proactive, systematic, and consistent approach addressing enrichment programs for all laboratory animals is encouraged throughout NIH.

One goal of the Guide for the Care and Use of Laboratory Animals (NRC, 1996) is to "promote the humane care of animals… and provide information that will enhance animal well-being". Environmental Enrichment (EE) is the provision of stimuli that encourage species appropriate behavior and provides for an individual animal's physical and psychological needs. EE is achieved by modifying a captive animal's environment with the goal of providing the animal with a wider range of behavioral opportunities (Mellen and Ellis, 1996; Shepherdson, 1992). Thus, successful EE programs take into account all aspects of a species' natural behavior, including social organization, foraging behavior, and daily activity of the animal (DVR Environmental Enrichment Plan, 2004; Poole and Dawkins, 1999; Steward and Raje, 2001). Non-species specific factors, including the impact of economic and ergonomic considerations, as well as the possible implications to on-going research, must also be weighed when designing an enrichment program (Olsson and Dahlborn, 2002; van Loo et al., 2002).

The Guide (NRC, 1996) describes three elements that should be addressed when managing animal behavior. They are the structural environment, the social environment, and activity. The structural environment refers to components of the primary enclosure such as "cage furniture, equipment for environmental enrichment, objects for manipulation by the animals, and cage complexities" (NRC, 1996). Shelves, perches, nesting material, tunnels, and other objects that promote the expression of species typical behavior are examples of structural enrichment. The social environment addresses attempts to meet an animal's social needs. This can be accomplished by allowing members of the same species to have physical and/or visual, auditory, or olfactory contact with one another. Activity can mean providing an animal the opportunity for exercise, but can also allow an animal to engage in cognitive learning and social contact.

Several recent publications have summarized and reviewed the effectiveness and usefulness of providing environmental enrichment to rodents (Bayne et al., 2002; Jennings et al., 1998; Mortell, 2001; Olsson and Dahlborn, 2002). The following describes some of the major research findings upon which recommendations in each of these categories are based.

In their review of enriched environments for mice, Bayne et al., (2002) noted that performance in open field tests, animal docility, corticosterone levels, and adrenal gland weights did not appear to be affected by the application of long term enrichment. Some evidence does exist which suggests that singly housed mice may have a compromised immune system when compared to socially housed mice (Schwartz et al., 1974). Moreover, mice developed tumors faster when individually housed than when kept in groups (Riley, 1981). In rats, the provision of increased structural complexity has the

potential to promote modifications in brain structure, physiology (Park et al. 1992), and function (Goldman et al., 1987; Renner and Rosenzweig, 1987). These changes are mediated via increased cortical thickness (Diamond et al., 1987), increased dendritic spine density and increased concentrations of oligodendrocytes (Katz and Davies, 1984). In situations in which these changes may impact the outcome of the research, Animal Care and Use Committees and investigators should work together to balance animal welfare concerns with study objectives.

Social enrichment: Whenever possible, rodents should be housed socially in compatible groups. Mice can be successfully group housed if the social structure is limited to one male with several females and if the dominance hierarchy has been well established. Female mice can be kept in groups consisting of familiar animals (Wolfensohn and Lloyd, 1998). Escalating aggression in male mice of some strains may preclude social housing, but male rats seem to adapt well to group housing situations (Barnett, 1975; Brain 1992; Mortell, 2001).

Nesting: Mice build nests in the wild. The type and kind of nest built varies by species (Brain and Rajendram, 1986). Providing nesting material to laboratory rodents is relatively simple. Previous studies have shown that mice readily use several different types of nesting materials including shredded paper, paper towels, paper strips, commercial nesting fiber, wood shavings and wood wool (Blom et al., 1996; Sherwin, 1997; van de Weerd et al., 1996, 1997, 1998a, Table 1 & 4, Olsson and Dahlborn, 2002). The addition of nesting material to a mouse cage addresses both activity and structural enrichment.

Cage structures: As with nesting materials, several different types of structural enrichment have been tested with mice. Tunnels, nest boxes, Perspex boxes, opaque and cardboard tubes are just a few of the structural items available. The resultant effects of providing structural enrichment items to mice are not as conclusive as they are for nesting materials. The Canadian Council on Animal Care (1993) reported that results obtained from experiments examining appliance usage, i.e., cage structures, by mice were equivocal. However, positive effects of providing structural enrichment for mice are noted elsewhere. For example, cages with nest boxes are preferred to cages without a nest box (van de Weerd et al., 1998b; several different types of nest boxes tested). Additionally, structural enrichment of cages housing male mice resulted in increased exploratory behavior, less bar gnawing, and less drinking behavior (Leach et al., 2000, provided plastic inserts with raised platforms and shelters). Another study reported that some male mice explored more and slept less initially following the addition of nest boxes, but this effect disappeared over time (van Loo et al., 1996). Haemisch and Gärtner (1994) noted increased aggression between male mice following changes to their structural environment. The Rodent Refinement Working Party (Jennings et al., 1998) recommends structural enrichment with the proviso that it may be contraindicated if increased aggression among male mice is observed. In preference tests, laboratory rats consistently choose environments with nest boxes and shredded paper over unenriched environments (Manser et al., 1998). When given a choice between a nest box and shredded paper, the rats choose the environment with the nest box (Patterson-Kane,

2000). Rats demonstrated a preference for cages with wooden platforms, wood chips and paper towels over a barren or empty cage (Bradshaw and Poling, 1991).

The ILAR Rodent Guide (NRC 1996) suggests that individually housed rodents prefer sheltered areas within their home cage. This may offer rodents opportunities to control the amount of light and/or to seek out higher areas within their cage. Shelters may be an effective way to enrich the environment (NRC, 1996).

Conclusions

Based on this review, the following guidelines are suggested for housing rats and mice in the laboratory.

- Rats and mice benefit from being socially housed whenever possible.
- Mice benefit from being housed on nestable bedding or being provided with a suitable substrate with which to build a nest.
- Rats benefit from being provided with increased structural complexity, i.e., nest box, platforms or paper towels.

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