Legal Space Requirement Stipulations for Animals in the Laboratory: Are They Adequate?

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Animals in the laboratory need the legally required "empty space" to meet their basic spatial requirements for postural adjustment, but they also deserve functional structured space for species-typical locomotor behavior and dynamic interaction with their physical environment. Primary enclosures of these animals traditionally are unfurnished, and there is no reason to believe that the biomedical research industry will change the status quo on its own accord. Rather than counting on the professional judgment of attending veterinarians, investigators and facility administrators, The U.S. Department of Agriculture should explicitly require primary enclosures of laboratory animals to provide not only a specific volume of space, but also species-appropriate space structured for optimal use by the confined subject.

Cage space, because of its relatively high cost, is one of the most contentious issues in the discussion of welfare of animals in the laboratory. To assure that these animals are kept in primary enclosures which, at least, meet their spatial demands for normal postures and postural adjustments, the U. S. Department of Agriculture (USDA, 1995) prescribed specific space requirements for each regulated species. The allocations mandated were described in terms of minimum floor area per animal and minimum height of the primary enclosure. These figures are determined by the individual animal's body weight category or size, with nursing dams requiring additional floor space.

The legal minimal space of the primary enclosures is so cramped that laboratory animals commonly develop stereotypical movement patterns such as monotonously running in circles, pacing back and forth, swaying from side to side, tossing the head up and down, bouncing up and down, or somersaulting. These behaviors suggest that the space allocations are insufficient (Callard, Bursten, & Price, 2000; Draper, & Bernstein, 1963; Gunn, & Morton, 1995; Kitchen, & Martin, 1996; Mason, 1991; Paulk, Dienske, & Ribbens, 1977; Salzen, 1989). Several investigators have challenged this assumption and conducted experiments to demonstrate that laboratory animals do not need more than minimum space allowance and, in fact, would not benefit from larger than minimal primary enclosures.

EXPERIMENTS

Hite, Hanson, Bohidar, Conti, & Mattis (1977) examined activity patterns and health parameters of two groups of 16 individually housed male beagles in standard cages (0.58 m2 x 76 cm) and in larger experimental cages (1.74 m2 x 76 cm):

> *Dogs in the larger cages did not utilize the additional floor space, which was three times the area of the standard size cage. It was found that they spent 53-66% of their time sleeping or lying, compared to 25-40% standing which is the only position from which dogs could ambulate, suggesting that the voluntary exercise requirement of laboratory bred beagle dogs is much less than previously supposed (p. 64).*

Hite et al. (1977) inferred from their findings that "the sizes of the standard cage appear to be adequate for laboratory beagle dogs and no advantage was found when the dogs were in larger cages with respect to behavior, patterns of activity, or health" (p. 64). Campbell, Hughes, Griffin, Landi, & Mallon (1988) conducted a similar study several years later and confirmed that "the size of the cage [unfurnished standard cage versus unfurnished, double-size standard cage] had no significant effect on the amount of time a [male beagle] dog spent in a nonexercise state" (p. 1300).

White, Balk, & Lang (1989) tested the "adequacy of these [mandated] space allocations" (p. 208) for breeding guineapigs by observing groups of four or seven animals in an empty plastic cage:

> *Results of the study revealed that breeding groups of guinea pigs utilize the periphery of the cage almost to the total exclusion of the centre of the cage. Approximately 75-85% of all occupancy in both the day and evening hours occurred in 47% of the cage floor area located along the periphery. (p. 208).*

The conclusion was drawn "that 4636 cm2 of floor area provides adequate space for a breeding group of seven guinea pigs, even though this is 40% less than current USDA guidelines" (White et al., 1989, p. 213). Referring to these findings, the National Research Council (1996) made the following statement:

> *Studies have found that compatible social groups of rodents do not use all the available space recommended in current guidelines and probably do not require it for well-being (p. 48).*

Fullwood, Hicks, Brown, Norman, & McGlone (1998) kept groups of three male mice in unfurnished cages in which floor areas ranged between 32 cm2 and 129 cm2 per mouse. "Mouse mortality - determined by the university veterinarian to be due to bite and attack wounds - was greater as more space was provided." The authors concluded that "socially housed male C57BL/6 mice will benefit from less space than recommended by the NRC [National Research Council] in 1996" (pp. 34-35).

Galef, & Durlach (1993) allowed rats to choose between a 17-cm high unfurnished cage and a 23-cm high unfurnished cage. The animals did not exhibit a preference for the higher cage. Galef (1999) deduced from this that "our results failed to provide support for the hypothesis that rats were less comfortable when held in shorter cages than when held in taller ones" (p. 273). He cautioned that "increasing cage height may not be a particularly appropriate way to expend finite resources in the attempt to increase the welfare of laboratory rats" (p. 273).

Line, Morgan, Markowitz, & Strong (1989) tested six single-housed rhesus macaques in unfurnished standard cages (0.40 m2 x 61 cm) and in unfurnished larger experimental cages (0.57 m2 x 81 cm). They detected no differences with respect to cage size in activity, abnormal behaviour and heart rate and deduced from this that "enclosure size was not a measurably important aspect of the environment" (p. 1525), and that "modest increases in cage size are unlikely to enrich the environment of singly caged laboratory primates" (p. 1523).

In a subsequent study with 10 rhesus macaques kept in three different-sized unfurnished cages, Line, Morgan, Markowitz, and Strong (1990) cautioned that the USDA-proposed "changes in cage size will not improve well-being in any measurable ways" (p. 110). Similarly, Crockett, Bowers, Shimoji, Leu, Bowden, and Sackett (1995) noted that the behavior of 20 adult long-tailed macaques "did not differ in any analysis" (p. 368) when the animals were individually housed in unfurnished cages of regulation size, a size 23% smaller, and a size 48% larger. The authors "found no behavioral evidence to refute the null hypothesis that the minimum cage size established [by USDA, 1995] for 3-10 kg macaques is adequate" (p. 380), and underscored that abandoning cages that "are just a few centimeters too small" or "spending many dollars to enlarge them will not be repaid in meaningful increments in psychological well-being" (p. 381). Crockett, Shimoji, and Bowden (2000) confirmed the findings of this study in pig-tailed macaques and made it clear that they "do concur with the view that cage size, within the wide range addressed by USDA regulations is one of the least important factors in the promotion of psychological well-being in primates" (p. 78).

A FLAWED STATEMENT

These reports offer a quasi-scientific endorsement of the notion that legal minimum cage space requirements are sufficient and that any additional space would be a waste of money. That the studies were carried out with unfurnished cages flaws this seemingly clear-cut statement. What should an animal do with more, yet empty space? It would be naïve to expect a dog, a guinea pig, a mouse, a rat, or a monkey to run around spontaneously, explore the environment and make use of the vertical dimension of the enclosure just because the volume of space has enlarged. To make use of the horizontal and vertical dimension of space and move around freely without fear of predators or dominant social companions, commonly used laboratory animals need structures which make the space accessible (e.g., elevated platforms and perches) and safe (e.g., visual cover and wall contact).

SPECIES-APPROPRIATE SPACE

There is no doubt that the findings of the cited reports would have been very different, if the animals had been tested in cages furnished in species-appropriate ways. Under such conditions, more locomotor activity and better behavioral health can be expected in larger enclosures than in smaller enclosures (Daschbach, Schein, & Haines, 1983; Brent, 1992; Kitchen, & Martin, 1996; Leu, Crockett, Bowers, & Bowden, 1993; Nakamichi, & Asanuma, 1998; Williams, Steadman, & Kyser, 2000).

Laboratory animals deserve larger than minimum-sized cages, and there is no reason to believe that they would not benefit from additional space which is made usable by means of structures. Such structures should be mandated. "Basing cage-size recommendations on floor space [and height] alone is inadequate (National Research Council, 1996, p. 25; see also Bayne, & McCully, 1989). Federal legislation should stipulate explicitly that primary enclosures of laboratory animals not only must provide a specific volume of space, but also that it must be structured in ways that allow the confined subject to make optimal use of that space in species-appropriate fashion.

As a starting point, USDA (1995) tied the minimum space requirements for cats with the stipulation that "each primary enclosure housing a cat must contain a resting surface" (p. 41). This clause provides a safeguard that cats are not permanently restricted to the terrestrial plane of the enclosure but that they also can access an elevated vantage point from which to monitor their surroundings (Rochlitz, 1999). Similar clauses should be added for all the other species of laboratory animals. For example, compelling evidence shows that dogs, rabbits, rodents and nonhuman primates no less than catsbenefit from elevated resting surfaces (Bigler, & Oester 1994; Goff, Howell, Fritz, & Nankivell, 1994; Hansen, & Berthelsen, 2000; Hubrecht, 1993; Leach, Ambrose, Bowell, & Morton, 2000; Nakamichi, & Asanuma, 1998; Neveu, & Deputte, 1996; Reinhardt, 1990; van Wagenen, 1950). Evidence also shows that cover or visual barriers make central areas of enclosures more attractive and reduces aggressive tension between animals who live in pairs or groups (Anzaldo, Harrison, Riskowski, Sebek, Maghirang, Stricklin, & Gonyou, 1994; Erwin, 1977; Gunn-Dore, 1997; Townsend, 1997; Maninger, Kim, & Ruppenthal, 1998; Reinhardt, & Reinhardt, 1991; Ricker, Williams, Brady, Gibson, & Abee, 1995; Westergaard, Izard, Drake, Suomi, & Higley, 1999).

It would be indicated to repeat the studies, which concluded that enclosure size is not an important aspect of an animal's environment, with enclosures that are not empty but properly structured.

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