Enrichment Strategies for Laboratory Animals from the Viewpoint of Clinical Veterinary Behavioral Medicine: Emphasis on Cats and Dogs

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Abstract

Behavioral wellness has become a recent focus for the care of laboratory animals, farm and zoo animals, and pets. Behavioral enrichment issues for these groups are more similar than dissimilar, and each group can learn from the other. The emphasis on overall enhancement for laboratory dogs and cats in this review includes an emphasis on behavioral enrichment. Understanding the range of behaviors, behavioral choices, and cognitive stimulation that cats and dogs exhibit under non-laboratory conditions can increase the ability of investigators to predict which enrichments are likely to be the most successful in the laboratory. Many of the enrichment strategies described are surprisingly straightforward and inexpensive to implement.

Key Words: affiliation; behavioral enrichment; environmental enrichment; mental stimulation; normal behavior

Introduction

The decade of the 1990s was marked by increased concern for the welfare, well-being, and humane handling of food, laboratory, and display animals, regardless of species; and this concern continues (Appleby 2003; Barnett et al. 1994; Baxter 1994; Blokhuis and Metz 1992; Carstead et al. 1993; Colahan and Breder 2003; Fraser et al. 1997; Hurme et al. 2003; McRobert 2003; Prescott and Buchanan-Smith 2003; Reinhardt et al. 1991; Rochlitz 2000, 2002; Seidensticker and Forthman 1998; Selzer et al. 2004; Warwick 1990; Weiss and Wilson 2003). The current Specifications for the Humane Handling, Care, Treatment, and Transportation of Dogs and Cats (summary in AWR 1985) focus on (1) keeping dogs and cats physically safe and well, (2) regulating the needs for warmth, cleanliness, dryness, and shelter in all environments, and (3) providing easy access to clean food and water and adequate space.

The 1990, 1991, 1997, and 1998 modifications (summarized in AWR 2003) of these regulations reflect the published primary literature: For the first time, compatibility between animals housed together becomes a focus. Ironically, compatibility is to be determined by observation. Whether an animal will be "compatible" with another will depend on age, sex, whether they are both relatively "normal," and the degree to which their "temperaments" match. Unfortunately, terms such as normal and temperament are usually left undefined. In the canine literature, both the definition and assessment of temperament have been of interest since the time of Darwin (1872), and have been debated for decades. The debate has been less vociferous when cats are the subject, possibly because we do not ask cats to work in service positions as we do dogs. However, the issue of temperament in cats is far from resolved. A review of the literature in ethology and veterinary behavioral medicine reveals that definitions of normal and abnormal behavior and normal ranges of feline and canine behaviors remain incompletely understood.

Concerns for the well-being of animals other than cats and dogs (e.g., farm and exotic animals) have led to regulation. In 1990, the US Department of Agriculture began to regulate horses and other nonequid farm animals used for biomedical research, other nonagricultural research, and nonagricultural exhibition. Later the same year, housing and transport requirements were enhanced for guinea pigs, hamsters, and rabbits—animals that have become popular as "pocket pets." Accordingly, if we are to address behavioral, mental, and environmental enrichment as part of an overall welfare issue in any research animal—whether or not that animal is housed in a laboratory—we must understand normal behavior, its variability across and between breeds and species (Overall 2005), and ways to train people to assess changes that may be the result of the constraints of the research in which the animals are used.

Normal Cat Behavior and Effects of Environmental and Behavioral Stress

Feline behavior has received sporadic attention over the years, but as cats increase in popularity as pets in the United States (AVMA 2002), their behaviors have received more attention. In part, this increased interest in feline behavior is due to the fact that behavioral concerns are the primary reason that cats are relinquished, abandoned, or euthanized in the United States (New et al. 2000; Scarlett et al. 1999).

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Welfare concerns are not usually addressed in the same depth within a pet home as they are in a research colony (which is interesting in itself), but the same problems are likely to arise in both environments. Because of the well-established effects of stress in colony cats (Carstead et al. 1993), excellent measures of disruption that affect the social and behavioral environment are available and can be redressed by enrichment strategies in both the home and the laboratory.

Common responses of laboratory cats to stress include loss of appetite, withdrawal from social groupings, increases in salivary, blood, and urinary cortisol levels, increases in urinary cortisol:creatinine ratios (important when assessing routine panels for overall health), decreases in grooming, and an increase in frequency and intensity of attempts to hide. Thwarting attempts to hide can contribute disproportionately to any overall measure of stress. These findings, which are interesting in light of the evolutionary history of cats, likely pertain equally to pet cats and to those in laboratories.

Environmental Conditions

Cats were never truly domesticated in the same manner as stock animals (Clutton-Brock 1987) or dogs. In fact, one of the reasons for the relatively recent focus on cats pertains to the change in the living conditions of pet cats. Most cats in the United States no longer live in extended family groups, nor can they come and go at will (AVMA 2002). The story of cats and humans is the story of disease control (Overall 1997). Rodents have always been attracted to human societies and provide a decent meal for a small felid. Humans have allowed cats to attend human groupings, but there has been no selection for enhancement of specific behavioral traits, as has occurred in dogs.

The physical and behavioral diversity represented by specific breeds in cat fancy today has only existed for the past ~100 yr. For thousands of years, the "domestic" cats found in human settlements have been approximately the same size as current house cats and likely tabby, tricolor, or black. Cat size and color pattern are important evidence supporting our lack of intervention to "domesticate" cats. The range of size, coat color, and coat pattern of felids in the wild is orders of magnitude greater than that seen in domestic cats (exactly the opposite pattern seen in domestic dogs). Modern cats are crepuscular hunters whose ancestor, the African wildcat (*Felis lybicus*), evolved in sandy and grassy environments, where hiding was a normal part of adaptability and hunting for food and survival. In environments where small cats may also serve as prey for other species, hiding is an adaptive response to avoid predation. It is likely that both laboratory and pet animals display these same adaptive behaviors and have undergone almost no change in at least 12,000 yr (Clutton-Brock 1987).

Species-specific Behavior

Recent research on feline behavior demonstrates the extent to which domestic pet cats maintain the same behaviors as do groupings of free-ranging African wildcats and free-ranging domestic cats. Cats live in matrilineal groups in which related females share the care of the young (Bradshaw and Cameron-Beaumont 2000; Crowell-Davis et al. 2004; Curtis et al. 2003). Females make nests where the offspring of other females can be cared for during hunting forays, and related females will suckle each other's young (Feldman 1993). The extent of variation in group size depends on the resource environment (Dards 1978; Kerby and Macdonald 1988; Liberg and Sandell 1988; Macdonald 1983; Macdonald et al. 1987; Natoli 1985b). Males may help to provide care for related young until they are mature either sexually (~6-9 mo) or socially (~2-4 yr), another situation that depends on the resource environment (Dards 1983; Macdonald and Apps 1978; Macdonald et al. 1987; Natoli and De Vito 1991; Natoli et al. 2001; Yamane et al. 1996).

The aspects of the behavior of pet cats described above also factor into the behavior of cats in laboratories. Elimination of waste, the most common behavior problems in cats, often includes spraying and lack of litter box use, which are largely the result of anxiety disorders (Overall 1997). Most anxiety disorders are provoked by social and environmental stress or distress, and problem behaviors that occur both in the laboratory and in the home often result from disruption of social structures, stress related to the addition of an unrelated animal, loss of cat-cat social contact, and decreased opportunities to learn from other cats (Chesler 1969; Crowell-Davis et al. 1997; Neilson 2003).

Wild or free-ranging cats urinate frequently and spray much of their urine to delineate areas through which they frequently traverse (Feldman 1994; Macdonald and Apps 1978; Natoli 1985a,b). Study results have established baselines for number, location, and types of elimination behaviors in a feline laboratory colony for comparing changes associated with colony manipulation.

Recommendations for decreasing stress and enriching the mental and physical environments for cats all include suggestions that tacitly mandate mimicry of the social system of a species for which humans have had relatively little impact on daily behavior. Cats in homes normally urinate two to four times per day and defecate one to two times per day. Defecation that occurs every other day can be considered normal in the absence of health effects (Overall et al. 2005). One of the routine recommendations for the well-being of laboratory cats and for stress reduction includes the provision of multiple litter boxes that are cleaned frequently (Loveridge 1998). For a pet cat, "frequently" means scooped multiple times per day as needed, and completely dumped at least every other day. If the litter is of the clumpable variety, it still should be dumped weekly because scents and small particles of feces can coat the surfaces of individual grains.

The litter provided laboratory cats should be reliable but variable because it also supplies tactile and olfactory stimulation and enrichment. Because multiple litter boxes should be provided, variety can be introduced without also abruptly changing the litter substrate the cat is using—a formula for disaster (Neilson 2003). Materials that cats like to explore include straw, paper, shavings, fabrics, paper, wood chips, and buckwheat husks (McCune 1995). These materials can also provide alternate litter environments. Litter trays or boxes should be at least 1.5 times the length of the cat's body, of varying depths, and placed in a variety of environments to address potential social conflicts, resource guarding, and temperament concerns for very shy cats (Karsh and Turner 1988).

Feeding

Ad libitum or meal feeding tends to be the easiest method for feeding both laboratory and pet cats; however, these styles may not be the best for any cats. In their evolutionary history, cats have never encountered a continuous feeding environment. Instead, they have eaten multiple small meals throughout the day. Newer recommendations for pet cats include feeding them only from treat balls (now commercially available) if they eat dry food, hiding dry food at various levels and behind various objects, and placing wet food in very tiny amounts on a variety of surfaces two to three times a day while rotating the locations (Overall et al. 2005). Both wet and dry food can be used in puzzle boards that require the cat to use their paws. Food puzzle diversity is limited only by the creativity of the keepers of the cats. All commercially available food toys can be washed and sterilized. This strategy allows the cats to "hunt" and provides a source of otherwise devoid intellectual stimulation.

Food dispensers that require the cats to do something to receive the food are good options in multicat environments (McCune 1995). Interestingly, the association between foraging activity and enrichment may be viewed in another way: Cats that exhibit signs of stress, including alopecia, have been observed to exhibit polyphagia and become obese when housed without other cats (DeLuca and Kranda 1992).

Housing

It is clear that in a laboratory, no cats should be housed as singletons or in "duplexes." In duplex environments, one cat is housed above the other, sometimes with a connecting door. Given the feline propensity to seek hiding spots and to use elevated spaces, duplex housing likely creates both stress and distress for cats. Cats should instead be housed in maternal groupings or grouped by affiliation, taking the effects of age and sex into account. These simulated family groupings are likely to produce the most "normal" feline social behaviors.

Free-ranging cats occupy an average of 0.48 to 990 hectares during a season (Macdonald and Apps 1978). This information indicates that the average urban apartment in the USA is approximately 10 times too small for the average cat, a situation that is worsened by the addition of other unrelated and/or unfamiliar cats. Crowding effects may be intensified in laboratory environments. Specifications for cat enclosures are as follows: Each primary enclosure must be at least 24 in (60.96 cm) high, and have 3 ft^2 (0.37 m^2) of floor space for each 4-kg cat. Cats larger than 4 kg must have 4 ft^2 (0.37 m^2) of floor space (AWR 2003). Although queens with kittens receive an additional allotment of floor space, cats in laboratory enclosures have considerably less area available to them than they would choose to use. In other words, efforts to ensure that cats have a physical environment that is enriched, complex, and challenging, and a behavioral environment that facilitates maximal use of the physical features, are of paramount importance.

Bernstein and Strack (1993) found that when cats were provided with 10 m^2 of space, each cat was able to avoid or resolve conflicts. Cats have used three-dimensional space in contained as well as free-ranging environments. Therefore, virtually all recommendations for colony cats include a provision for complex stimulating three-dimensional space (Loveridge 1998; McCune 1995). The Animal Welfare Act has mandated the inclusion of at least one elevated resting place (AWR 1985).

Training and Handling

Because it is now accepted that cats can and should be trained in the same way dogs are trained (Overall et al. 2005; Seksel 2001), we should train laboratory cats not only to tolerate routine procedures, but also to expect them and to cooperate. To accomplish this goal, only positive reinforcement learning techniques should be used. In cats, especially, forceful training techniques will backfire because the animals have never been selected to work truly cooperatively with humans. The investment in education about positive training techniques will pay off not only in the well-being of the animals, but also in job satisfaction for kennel staff and in the quality of the data obtained.

Novelties and Other Manipula

The idea of incorporating novelty into cats' spaces is supported by studies investigating increasing degrees of complexity of environments (e.g., Ibáñez et al. 2001). Most commonly recommended are the following: multiple perch sites, especially if they have hiding areas in which cats can retreat but not become trapped; spaces with variable functions (e.g., they have hinged aspects that can change their use and appearance); those coupled with toys that move; spaces that provide access to other cats; and those that provide access to windows overlooking stimulating behavioral environments, including humans and other cats. Additional enrichment can be achieved by including rope toys, hanging ropes, walls or boards covered in carpeting for scratching, and so forth.

It is easy to expose cats to early experiences with devices (e.g., crates, treatment and transport carts) by leaving crates and carts throughout the housing facility so that the cats can occupy or explore them at will. If it is necessary to take cats in and out of cages and to leave them unconfined for any distance or amount of time, it may be advisable to teach them to walk on leads and harnesses because this instruction will not only make such trips stress free, but will also add another level of enrichment while providing handling options that do not rely solely on frank restraint. By providing agility equipment within group and family housing (e.g., tunnels, ropes, beams, seesaws, steps, A-frames, trees), cats can obtain natural forms of exercise and develop coordination and balance while learning to play fun games. All commercially available crates and equipment can be easily washed with bleach.

Socialization and Stimulation

The roles for social interaction with and handling by humans cannot be overemphasized. Karsh and Turner (1988) demonstrated profound effects of even small amounts of daily attention on cats in the following ways: their outgoingness, the ease with which they allowed themselves to be handled, and their willingness to engage in unfamiliar situations. Furthermore, such effects are multiplicative—the more time spent in such handling, the more outgoing, friendly, and confident the cat.

Early handling of nondomesticated animals is essential for a good rapport between humans and the animal, and nowhere is this more clear than for cats. By 8 wk of age, the benefit to the cat of early handling diminishes, and cats that were not handled until 14 wk of age—when they are out of the social play developmental period and into the social fighting period—had little to no effect on their responses to humans within the constraints of the experiments. Early handling of very young kittens also has neurodevelopmental effects, including early ability to regulate temperature and early development of color. In Siamese cats, color "'points" (e.g., color on the tail, ears, and/or mask that differs from the rest of the body) (Meier 1961) develop earlier in kittens that are handled.

Summary

It is unlikely that the results of baseline neurochemistry, medications, and a variety of other systems evaluated in experimental situations will be consistent in stressed versus nonstressed animals. The quality of data obtained from laboratory cats—regardless of research focus—is likely to be greater for cats living in enriched environments that meet their behavioral, social, and physical needs. A summary of sentinel recommendations for enrichment in cats appears in Table 1.

Table 1. Enrichment recommendations for cats

- Provide ample space.
- Provide variable purpose, variable height, and variable dimension perch spots.
- Provide numerous litter boxes at least 1.5 cat body lengths.
- Provide a choice of litters and substrates cat can also explore without having to use them for elimination (e.g., boxes of straw).
- Distribute beds/perches/water dishes/food dishes/toys, and other provisions so that they are not clumped and they are placed over a range of heights and habitats, if available.
- Provide a window where cats can see humans or other animals, or at least provide video stimulation.
- Allow cats to live in extended family groups; if adding cats, try to add related females, especially if the colony is a breeding colony.
- Choose toys for their stimulus value: ropes, rope toys, plants that are safe for cats to eat, scratching posts or boards covered with carpet for scratching are all inexpensive and safe ways to render environments more enriched.
- Hide food and use food puzzles or food toys in a pattern, frequency, and distribution that simulates hunting.
- Groom and handle cats often, preferably daily.
- Expose kittens to all available and anticipated stimuli from 2-8 week, minimally, and preferably through 12 wk of age.
- Train all cats to sit, stay, and lift neck (as for venipuncture), and to tolerate nail trim, tooth brushing, temperature taking, and any other manipulations to which they might be routinely subjected.
- Expose cats to transport crates throughout, and leave them in the housing facility so that they can be occupied or can explore at will.
- Teach cats to walk on leads with harnesses if they are expected to be transported and taken in and out of crates.
- Provide agility types of equipment (e.g., tunnels, ropes, beams, see-saws, A-frames, hoops) so that the cats can have exercise and develop coordination and balance while learning to play fun games.
- Massage cats, especially after some scary event; this needs to be only for 1-2 min and should involve long, slow, firm strokes.

Normal Dog Behavior and the Effects of Environmental and Behavioral Stress

Unlike cats, dogs share both a foraging mode and a social system virtually identical to that of humans (Overall 1997). Dogs have coevolved for cooperative work with humans for approximately 135,000 yr (Leonard et al. 2002), with intense selection for specific suites of behavioral traits (e.g., the development of breeds) occurring in the last 12,000 to 15,000 yr (Leonard et al. 2002; Parker et al. 2004; Vilà et al. 1997, 1999; Wayne and Vilà 2001). Dog breeds were developed on the basis of specific work or jobs such as the following: border collies, Australian shepherds, and Australian cattle dogs for herding; Labrador retrievers for retrieving in water; beagles for alerting to hidden prey; Jack Russell terriers for tracking and killing small prey; and Belgian Malinois for herding, guarding, and protecting the flock.

Dogs mirror humans in hallmarks of social development (Overall 2000) and, like humans, are subject to maladaptive anxiety—a state that interferes with normal functioning. This type of pathological anxiety was selected against during the coevolution of dogs and humans. With the emergence of dog fancy, wherein form is valued over function, many breeds and lines within breeds now manifest heritable physical and behavioral pathologies, including those associated with anxiety (Ketteritzch et al. 2004; Overall and Dunham 2002; Strain 2004; Todhunter et al. 2003a,b).

As in human medicine, the concept of normal behavior is usually left undefined in veterinary medicine. Normal behavior may be best gauged by two components: (1) an individual's ability to recover from provocative experiences, and (2) the ability to learn to make mistakes profitably. This definition pertains to both inter- and intraspecific interactions and environmental exploration. Also as in human medicine (Narrow et al. 2002), anxiety disorders for pet dogs are among the most common health concerns (Overall 1997; Overall and Dunham 2002; Overall et al. 2001). Breed may influence the presentation of the anxiety disorders, as has been shown for obsessive-compulsive disorder, fear, and aggression. Colonies of different breeds of dogs may also manifest different stress-related behaviors associated with a lack of enrichment.

It may be necessary to tailor enrichment to breed-typical behaviors to ensure success. Regardless, it is not necessary for a laboratory dog to show the entire range of symptomology required to diagnose a behavioral condition to elicit concerns about enrichment. In fact, because so many behavioral diagnoses have a putative genetic basis, purpose-bred colonies can select against these conditions, if desired. Nevertheless, species and breed-typical behavioral and intellectual needs must still be met.

Environmental Conditions

Some researchers who have noted that dogs use more two-dimensional space than cats have recommended that dogs have access to three times the floor space required for cats (e.g., Moore 2004). The addition of three-dimensional space within any environment—including platforms, bridges leading to other levels, steps, beds, or resting spots—will likely enhance social opportunities while minimizing the effects of stress and distress (Hubrecht 2002; Wells 2004). Additional opportunities for social stimulation can be provided by the use of indoor/outdoor runs, in which the outdoor component faces an exercise area where other animals, including dogs, are playing. Runs in facilities in rural locations can take advantage of the native wildlife; well-positioned outdoor enclosures allow dogs to observe other species in their natural habitat. Inherent is these plans are barrier zones to prevent actual interaction and inoculation to prevent any potential disease transmission in either direction.

When dogs are trained to eliminate in one area or only under certain conditions, a range of choices for bedding becomes available to them. Bedding that cannot be easily destroyed or ingested is now widely available (see Selected Resources below) and has the additional advantage of preventing pressure sores. Providing bedding also has social advantages. Dogs play with bedding and use it as a platform to solicit play from others. Because dogs sometimes spend more time on the bedding than on the floor (Hubrecht 1993), it may be necessary to move the bedding to the front of the run to encourage the dogs to spend more time there and to take advantage of additional social interactions (Wells and Hepper 1998, 2000).

As for cats, numerous options should be available for dogs. Additionally, bedding used in conjunction with transport crates or carts can provide shy dogs with an opportunity to hide from or avoid visual and auditory contact with more rambunctious dogs. The caution here relates to entrapment. Very shy dogs must be prevented from becoming trapped in a presumed refuge because entrapment worsens all anxiety-related conditions and is correlated with the development of panic. A lack of choices correlates with increased stress and distress. When povided correctly, more choices correlate with enhanced behavioral health. This logic is reinforced in Specifications for the Humane Handling, Care, Treatment, and Transportation of Dogs and Cats (AWR 1985): Tethering of dogs—a condition that renders them helpless and with no control over their mobility or, in some cases, body posture—is not an acceptable means of enclosing or restraining a dog for any extended time. Certainly, if temporary tethered restraint is necessary for specific procedures, the logic and humanity of using a harness on a leash-trained dog becomes clear.

Finally, if the flooring allows dogs firm footing that permits jumping, some very creative toys akin to feline rope toys are available and can provide both mental stimulation and physical exercise. Aussie Dog Toys® manufactures a ball on a rope, with a spring that bounces up and down when batted or caught and that can support the weight of most laboratory dogs. These types of toys and food toys are the exceptions to the rule that the dog is most stimulated by toys when humans are also playing with them.

Dogs can learn to use a litter box, as do cats, yet this aspect of enrichment is seldom considered. Free-ranging or responsibly owned dogs are not forced to sleep or eat in the vicinity where they eliminate. Because scents are very important to dogs and because feces and anal sac secretions deposited on feces may convey to them important information about recent experiences and responses, "cleanliness" issues in laboratory dogs may be considerably more important than previously considered. By encouraging dogs to use dedicated elimination areas (e.g., a box with litter, a stone area over a drain with an automatic water rinse that turns on after elimination, or penned areas of sawdust that are changed daily), confined dogs will be able to exhibit elimination behaviors that are more comparable to their normal behaviors than is otherwise possible in most laboratory environments.

Species-specific Behavior

Exposing dogs to as many new social and physical stimuli as possible as they become physically able to handle them is one of the best ways to produce confident dogs that can cope in a variety of circumstances. Prohibiting exploration, exposure, and social interaction through 4 mo of age is sufficient to alter a dog's social behavior for life in the absence of intense remedial efforts (Scott and Fuller 1965).

Concerns about "fear periods" have been discussed, but these periods have been neither biologically defined nor measured. Rather than experiencing a fear period at 9 to 10 wk of age and approximately10 mo, as is commonly claimed for dogs, two other phenomena are likely: (1) The 9- to 10-wk-old puppy that becomes fearful of a stimulus has probably learned recently that the world is not a wholly safe place. Puppies quickly learn this particular lesson as they begin to explore the outside world energetically and independently, starting at about 7 wk. (2) The 10-mo-old adolescent is segueing into social maturity and undergoing neurochemical changes (Overall 1997). These changes may cause the adolescents to view the environment differently and may encourage them to provoke the environment to obtain information about it. In so doing, these young dogs may place themselves in situations that are potentially risky and scary. Normal dogs learn from such events. In both of these cases, the animals should be able to recover if they were not traumatized. If dogs are not recovering within 1 day of a potentially provocative event, closer inspection is warranted. In addition, it may be necessary to protect some animals from an environment that is too challenging for them at a particular time.

Laboratories often report setbacks when they permanently tattoo dogs. In such a situation, the administration of analgesia may help to avoid the development of a fearful response, as may administration of a benzodiazepine (e.g., 0.5-2.0 mg/kg of diazepam) 2 hr before the procedure. It is important to mention that microchipping is much more cost effective in terms of personnel and time involved, and the process provides unambiguous identification for researchers and shippers. The drawback for this procedure in the United States has been the lack of a uniform system with universal microchip readers. This problem has added to the cost, and it complicates identification of dogs that may be exchanged between institutions. These problems do not exist in Europe and Australia, much to the benefit of both laboratory and production animals. It is essential to develop such systems as we track emergent diseases. Furthermore, it is critical for individuals skilled in laboratory animal medicine to provide leadership in this area.

Effect of Noise

Decibel levels of ambient noise directly affect the stress levels of dogs. Decibel levels may also have an indirect effect on behavior because signals may not be communicated or understood accurately in noisy environments. Although the noise in dog kennels often exceeds 100 decibels, data indicate that 90 decibels are sufficient to damage human hearing, and dog hearing is much more sensitive than human hearing (Hubrecht 1995). Given recent findings that dogs communicate significantly about their behavioral state and arousal level using vocal signals (Yin and McCowan 2004), it may be necessary to consider acoustic protection for dogs that also preserves their signaling abilities. It may be appropriate to initiate the installation of acoustic tiles and flooring, as a place to begin. Substrates that provide good traction, can be cleaned and sterilized, and provide acoustically friendly environments are now commercially available (see Selected Resources).

The untoward effects of kennel noise on handlers is well understood. One creative, partial solution for the problem of ambient noise is to alter it by playing classical music. Wells and colleagues (2002) found that barking decreased and resting increased in shelter dogs exposed to classical music. Interestingly, not all music is equal: Heavy metal music was associated with increased agitation in the same dogs.

Training and Handling

The single most important enrichment modification that can be made for dogs is to have humans handle them more frequently and in a greater variety of circumstances. Colony dogs that are taught to walk on a lead and with a harness, or preferably a head collar, are easier to handle. This practice also affords an opportunity to train/encourage the dog to eliminate in a designated area. Such tactics facilitate cleanup, lessen the probability of disease transmission, and keep the dogs clean and relatively odor free.

One aspect of kennel life that repulses many humans when handling laboratory dogs is the extent to which they are always covered in urine or feces. Being covered in elimination products is not the dogs' preferred state, is doubtless a source of social and olfactory stress for them, and is antithetical to their species-typical behaviors. By better addressing normal elimination needs and by using normal canine behaviors, we can likely affect the dogs' behaviors and those of humans who handle them. Indeed, dogs that are easy to groom will be groomed more often. Dogs for whom clean up and grooming are nontraumatic are more likely to anticipate grooming positively, and to associate grooming with desirable human interaction.

All dogs can be taught to sit, come, stay, and walk easily on a lead using a harness or a head collar. Additionally, like cats, dogs can be accustomed to transport and to treatment carts, crates, and routine procedures including nail trims, ear cleaning, teeth brushing, and blood sampling. With a reward-based system, it is possible to teach virtually all dogs that are humanely handled to extend an arm for a cephalic blood draw. Laboratory procedures progress smoothly and humans do not become angry or impatient when dogs are tractable. This factor is particularly important for laboratory dogs (and cats) because handlers may have these species at home as pets. Inappropriate treatment at home could easily spill over into a laboratory setting simply because someone assumed that the way they handled their pet dogs was normal and acceptable because the human's behavior was tolerated at home.

Laboratory animal colony managers may wish to screen the people who will handle the animals to determine their handling style and belief system of what constitutes appropriate handling and training techniques. Despite mandatory on-site education, those individuals who already feel that aversive techniques are suitable or superior for management and training could injure laboratory animals physically or behaviorally. It is very important not to underestimate the damage that early inappropriate care and handling can cause in dogs. A recent study focusing on police dogs (Schilder and van der Borg 2003) compared those trained with a shock collar with those trained in a comparable manner but without shock. The dogs trained with shock continued to show a subtle but wary response of their handlers (who were not the ones who shocked them) into the considerable future. Additionally, shocked dogs continued to exhibit behaviors and signals indicative of fear, anxiety, and distress in work and nonwork situations.

These data carry a powerful message for those in the laboratory animal community. It is incumbent on investigators to move from discussion and consideration of the extent to which different handling styles may affect the physiological and behavioral responses of laboratory dogs, to the measurement of these effects. These questions are particularly important for studies in which pharmacological or physiological outcomes are an important part of the data. When used in these studies, it is not likely that stressed and distressed dogs will produce data that accurately represent normal behaviors or responses.

Novelties and Other Manipulanda

As for cats, manipulanda (hereafter referred to as "toys") can make a huge difference in the life of laboratory dogs. Examples include food puzzles and food toys, with and without food (e.g., Busy Buddy® toys, Planet® toys, and Kongs®). All of these toys are available in hard rubber varieties that are long-lasting and can be washed and sterilized. The toys must be maintained in good shape to minimize any risk of choking or incurring obstruction by a foreign body. It is advisable for staff to keep a log at the front of each run, for noting when the toy was placed in the run and/or to which dog it was given; whether the item contained food and if so, what kind; and when it was removed and in what condition. If a human can flex these toys and see cracks, it is time to replace the toy.

Other food toys that provide mental and physical stimulation include Buster Cubes® and Roll-A-Treat® balls. These toys have the advantage that one dog can be batting the toy around, but many animals can be collecting the kibbled treats. If dogs are not aggressive around food and there is no food guarding, these toys can be an excellent addition, which may be substituted for ad libitum feeding in some situations.

Because some dogs are "food hogs," it is important to weigh puppies daily and adults regularly to note any weight gains or losses, particularly in group-housed dogs, when food toys are being used. Weight loss in this situation should cause the caretakers to re-evaluate the social interactions in the group. In addition, one final caution regarding Buster Cubes® and Roll-A-Treat® balls is needed: When athletic dogs whack the cubes and balls, these hard plastic toys can go flying and can injure a dog or a human. These concerns are not sufficient to deny laboratory dogs access to these toys, but handlers must exercise appropriate judgment about the conditions under which the dogs have access to the toys. For example, if two dogs share an indoor/outdoor run and are boisterous with these toys, one can be confined outside while the other is confined to the inside portion of the run. In this scenario, both dogs can have food toys.

Other toys can also help stimulate dogs, particularly when the toys "play back." Boomer Balls® are favored in kennel situations because they can be cleaned and are virtually indestructible. However, they can also do damage to anyone hit by them, and they can raise the decibel level if dogs play with them on hard, resonant substrates (see Effect of Noise). This latter concern about noise also pertains to Buster Cubes® and Roll-A-Treat® balls. Another example of toys that play back include empty, washed, polystyrene soda bottles (Wells 2004). Dogs bat these plastic bottles around and can chew them without ingesting them. The costs of these bottles range from cheap to free, so they can be replaced easily and generally cannot harm the dogs. In addition, unlike many food dishes and some toys, soda bottles contain no dyes to which dogs may be allergic. These types of toys are commonly and quite successfully used in shelter situations. By replacing or rotating toys frequently (Wells 2004), the dogs also receive the added bonus of more human contact.

Regular exercise is mandated, but not specified, for laboratory dogs (AWR 1985). Many of the ideas discussed above provide exercise. The best exercise for most dogs is another dog in an area sufficiently large for them to interact playfully. Many laboratory kennels use the central floor area for free play when individual runs are being cleaned. When possible, additional large spaces should be provided where dogs of like temperament can run freely and play together. Plastic kiddie pools can be incorporated into these areas and into large runs to provide both respite from the heat and new ways to play. Even if the dogs do not play with other dogs in the water, they may play with the water itself. Hard balls that can also be floated in these pools provide considerable mental and physical stimulation because dexterity is required to grab floating balls with teeth.

Socialization and Stimulation

Because dogs likely coevolved with humans, it follows that many of their responses to enrichment and welfare situations likely revolve around social interaction. For example, studies have shown that regardless of cage or run size, dogs will not exercise unless they have the stimulation of a human or of other, playful dogs (Campbell et al. 1988; Clark et al. 1997). This finding also characterizes elderly, cognitively impaired dogs that received the most potent social stimulation and enrichment from humans who interacted regularly with the dogs using a schedule of training exercises and simple, calming, affiliative behaviors (e.g., sitting on the floor and stroking the dog) (Milgram et al. 2004). The long history of human-canine coevolution may explain why contact with humans appears to be more beneficial to dogs in terms of decreasing stress, and why providing beneficial social experiences with humans renders dogs more outgoing and tractable than does mere contact with conspecifics (Fox and Stelzner 1966, 1967; Wolfle 1987). The effect of stroking a dog has been shown to increase affiliative neurochemicals in both dogs and humans (Odendaal and Meintjes 2003).

Interactions with other dogs are also important (Hubrecht 1995), and dogs should be kept at least in pairs and at best in family groups—real or simulated. Dogs provided with social opportunities, or social opportunities combined with complex environments (e.g., agility equipment and/or simple tunnels and ramps), are much more likely to engage in play, aerobic exercise, and social exploration (Hubrecht 2002). As with cats, dogs benefit from food toys that require them to use their brains, although meal feeding derives from the ancestral state. For example, bowls of food and water must be distributed in a pattern that prohibits resource guarding and the potential sequelae of true aggression.

Summary

Recent data indicate that dogs are significantly more similar to humans than are chimpanzees and wolves with regard to the complex social cognition involved in understanding long-distance signals that indicate where food is hidden (Hare et al. 1998, 2002; Miklósi et al. 2004; Topál et al. 1997). Dogs are further able to communicate information about hidden resources to other dogs (Pongrász et al. 2003). Given these findings, all dogs should receive some kind of training as mental stimulation and behavioral enrichment. A summary of sentinel recommendations related to enrichment for dogs appears in Table 2.

Lessons from Other Species

The rules that apply to dogs and cats do not govern other species; however, it is possible to enrich our pool of ideas on how to deal best with dogs and cats by reviewing some sentinel examples of how enrichment concerns have been addressed in nonlaboratory, production circumstances. Based on this premise, pertinent information and brief lessons from other species are presented below.

Farm Animals

Signs that farm animals are stressed or distressed are similar to those in dogs and cats: depression, anorexia, aggressive behavior (when none had existed before), fear and withdrawal, and ritualistic behaviors (Swanson 1994). The redress of many of these concerns involves normalizing the social and physical environment to the extent possible. For example, small family groups are the rule in ruminants, and the maintenance of these groups concomitantly with the ability to graze can greatly reduce the incidence of worrisome behaviors.

A large part of the problem with the assessment of farm animal welfare in the production environment involves the way we assess farm animal behaviors and our preconceived notions about particular behaviors, usually in the absence of data (Langbein and Puppe 2004). One could expect that when farm or production animals are used in a laboratory setting, behavioral evaluation may be even more complex. The key behavioral evaluation in farm animals must focus on relationships in social groups. Unfortunately, effects of social relationships have been inconsistently, and perhaps incorrectly, measured. For example, the individual behavior and foraging patterns of goats and cattle differ to the extent that the data available to assess enrichment concerns may be flawed because of assumptions about "normal" assessments that are inappropriate for the species examined. Additionally, species' differences in vigilance and locomotor behaviors may indicate the extent to which the physical or social environments appear uncertain to them (Jensen et al. 2004; Welp et al. 2004).

Table 2. Enrichment recommendations for dogs

- Provide ample space, including space for running, jumping, and avoiding other dogs.
- Provide variable purpose, variable height, and variable dimension resting spots; depending on the kennel design, elevated heated grids and bedding will also keep dogs warm, clean, and dry.
- Provide an area solely for elimination, and teach each dog to use it; consider adding leash walks to this paradigm, and reward the dogs every time they are seen eliminating in an appropriate spot (e.g., pens of straw; large surfaces of rock that can be hosed over grates).
- Distribute beds/water dishes/food dishes/toys and other provisions so that they are not clumped, and place them over a range of heights and habitats, if available.
- Provide a window where the dogs can see humans or other animals; if this is not possible, at least consider a full-spectrum light source and some video stimulation.
- Allow dogs to live in extended family groups if possible; otherwise, arrange by age and maturity.
- Choose toys for their stimulus value: ropes, rope toys, balls, plastic bottles are all inexpensive and safe ways to render environments more enriched.
- Hide food and use food puzzles or food toys in a pattern, frequency, and distribution that simulates thought and problem solving.
- Groom and handle the dogs often, preferable daily.
- Expose puppies to all available and anticipated stimuli for at least the first 12 wk of life; watch for severe distress responses and allow dogs to recover before they are gradually reintroduced to stimuli that may have created fear or stress.
- Rotate toys daily for visual, olfactory, and social stimulation; caged adult dogs can lose interest in a toy in only 2 days.
- Train all dogs to sit, stay, and lift neck or offer a forelimb for venipuncture, and to tolerate nail trim, tooth brushing, temperature taking, and any other manipulations to which they might be routinely subjected; the hidden advantage of this approach is that it renders unnecessary such procedures as scruffing and restraint, which can scare dogs and may require multiple people.
- Expose all dogs to transport crates throughout, and leave them in the housing facility so that they can be occupied or can explore at will.
- Teach dogs to walk on leads with head collars or harnesses if they are expected to be transported and taken in and out of crates.
- Provide agility types of equipment (e.g., tunnels, ropes, beams, see-saws) and kiddie pools so that the dogs can have exercise and develop coordination and balance while learning to play games.
- Talk to the dogs at all times; they will focus on the handler, and this focus on verbal cues acts as a mini-session in mental enrichment.
- Massage dogs, especially after some event that creates fear; massage only for 1-2 min, and use long, slow, firm strokes.

Consider: Establishing baseline measures of vigilance and nonproductive locomotor behaviors in dogs and cats would allow evaluation of the effects of any enrichment interventions. These baseline data, although currently missing to date, should be relatively simple to obtain.

Indeed, progress is being made in ways that are relevant to study animals. Recent work has examined vocalizations in farm animals. In a manner similar to that of Yin and McCowan for dogs (2004), Manteuffel and colleagues (2005) identified vocalizations used only when the animal is distressed, which can be compared with vocalizations used only when the animal is, for example, excited or soliciting attention from the mother or siblings. It is important to realize that in social animals, vocalizations or signaling of one animal affects the behaviors of another. In this context, the work on farm animals has been more progressive than that on cats and dogs. For example, we know that when cows vocalize, their calves experience a cardiac response that depends on the cow's vocalization. Similar results have been shown for other farm animal species. We should realize that such responses also must affect the hypothalamic-pituitary-adrenal cortex axis. In other words, it is possible to correlate vocal findings with fecal cortisol measurements and have two independent measures that would provide a daily index of well-being.

A similar approach is already being used in farmed pigs. A neural network model uses vocal data collected by an automatic detector and then identifies calls that could indicate impaired health or increased stress. Whether the farm animal species is avian or mammalian, the literature is in agreement—the intensity of the vocal signal usually mirrors the degree of distress or pain (Manteuffel et al. 2005).

Consider: By using the farm animal model of assessing and monitoring normal, we could continuously monitor dogs and cats for daily deviations that reflect potential welfare issues and could intervene as needed with various enrichments. To do this, we need to know what is normal in a laboratory environment. Because we live with dogs and cats as pets, we may think it is not necessary to assess normal behaviors under laboratory conditions. It is ironic that we have no such illusions in modern times about farm animals.

Chickens

Feather picking and cannibalism are common welfare issues with chickens that occur when the chickens are too crowded to engage in normal social behaviors (Hocking et al. 2005; Maria et al. 2004). Normal social behaviors in chickens involve the dispersion of family groups, therefore production husbandry interferes with normal chicken behaviors from the outset.

In assessing whether a behavior is normal, it is necessary to investigate any heritable basis for the behavior, or any breed or strain liability. In the latter case, what is normal for one breed or strain is not normal for another, a pattern that had not been extensively addressed in the enrichment literature until now. In chickens, there is a strong genetic basis for cannibalism and feather picking. This relationship is not independent of sociality: The more social the breed, the less likely the stress- and crowding-related behaviors (Hocking et al. 2005). Although breed- and strain-related behavioral responses have been noted in dogs (Murphree et al. 1977), no studies have looked at potential effects of these abnormal behaviors on litter mates or those housed in the same group. Additionally, regardless of strain, crowded chickens show fewer normal behaviors of any kind than do dispersed chickens. Crowded chickens spend more time immobile and explore fewer areas of the environment available to them (Arnould and Faure 2004).

Consider: Activity level and range of exploratory behaviors could comprise one measure of the extent to which dogs and cats need enrichment.

Physical responses may also be indicative of more subtle signs of stress. At high densities, chickens jostle each other more, and more chickens have gaits rated as impaired (Arnould and Faure 2004; Dawkins et al. 2004). Interestingly, environmental conditions that have direct effects on health also affect measures of chicken behavioral health. For example, high levels of litter moisture and ammonia correlate with leg and pad damage, leg deformation, and leg lesions. In fact, 84% of the variation in fecal cortisol in housed, commercial/production chickens can be explained by temperature, humidity, season, and ventilation type—all conditions that affect litter moisture and ammonia levels (Dawkins et al. 2004).

Consider: The incorporation of routine measurements of cortisol may be appropriate for laboratory dogs and cats, especially because these measures are now wholly noninvasive. Daily or weekly fecal cortisol measurements may indicate when the stress of social conditions increases.

Pigs

Pigs would normally live in family groups; however, intensive farming of pigs often requires them to live in groups larger than 50 animals. Group size affects the number of social interactions, their types, and their frequency (Turner and Edwards 2004), in addition to shaping the relationship between each sow and her piglets (Hötzel et al. 2004). In the latter case, such relationships affect weight gain and behaviors at weaning, and subsequent behaviors toward litter mates.

Consider: Although we do not evaluate the effect of the breeding environment either on indirect measures of health in laboratory puppies and kittens or on later behaviors of the offspring, we must perform these studies if we are interested in true enrichment. This necessity applies especially to studies in neuropsychopharmacology and neurobehavioral genetics, where ontogeny may have profound effects on the response substrate (Benefiel and Greenough 1998). This area is characterized by a glaring lack of baseline data in laboratory dogs and cats.

Rodents

In many experiments that use transgenic mice, it is necessary to house the mice separately or in pairs (Buehr and Hjorth 2003), which negates the innate social advantage of using mice in laboratory conditions. They innately live in groups because group living reflects their species-typical behaviors. One might surmise that because mirrors are often used as a form of enrichment for primates, it is not irrational to ask whether mirrors can help individually housed mice become calmer. Interestingly, however, mirrors increase stress and distress in mice and are most aversive to the mice (as measured by changes in behavior) during feeding (Sherwin 2004). This finding may not be surprising for a nocturnal prey species for which anxiety is a routine and adaptive response, and for which startle and unpredictable events may be maladaptive. In contrast, enrichment for mice may be as simple as providing space and resources that allow burrowing because mice readily build burrows when given the opportunity to do so. This behavior suggests the fulfillment of a "behavioral need" (Sherwin et al. 2004).

Consider: Providing dogs and cats with materials and giving them access to circumstances they would experience outside a laboratory may provide better information about enrichment than human intuition can provide.

Most laboratory mice used today are specifically bred and selected according to strains. We should not assume that all of these strains are the same behaviorally, or that they will respond to various neurochemicals or to the stimulus of neurochemical mechanisms in the same way. In fact, they do not. Antidepressant response in mice varies greatly by strain (Lucki et al. 2001), which should concern anyone interested in neuropsychopharmacology. Part of this response may correlate with various ontogenic parameters.

We now know that considerable genetic variation exists in some neurochemical receptors between breeds of dogs (Masuda et al. 2004; Nimi et al. 1999). Based on this information, we must consider fully how this variability may affect experimental outcome. We must consider potential breed effects when assessing neurochemical response to ensure that we are not studying artifacts. Additionally, knowing about these responses will allow us to tailor enrichment strategies to breed needs.

Primates

Enrichment programs for primates are very numerous and therefore beyond the scope of this article (see Mallapur and Choudhury 2003). However, findings from two recent studies are extremely relevant for the topic of enrichment in laboratory dogs and cats. The animals' available space—regardless of what is in it—has an effect, although it may not be the expected effect (Kaufmann et al. 2004). For example, in the absence of other stimulation, exploration and aerobic activities do not increase despite increases in available space. This finding makes sense in a profoundly social species and has equally important implications for dogs. Tension-related behaviors in dogs decrease significantly with increases in cage size (Wells 2004). It is likely that this response is a direct effect of increases in reactivity, which also appear in primates when they have fewer choices (e.g., no where to go)—one sequelae of "entrapment."

Consider: The effects of containment space and the behavioral choices it allows or precludes are important considerations when working with and transporting dogs and cats. Behavioral enrichment requires the evaluation of potential effects of heightened reactivity whenever containment changes. Because it is also esssential to acclimate the animals to any anticipated change, this process then becomes a form of behavioral enrichment.

The manner in which primates forage determines both the rate at which they forage and the rate and types of their agonistic relationships. It is important to provide foraging tools and to require animals to search harder for and work more dexterously to obtain food. The foraging process decreases agonistic events and occupies more time (Jones and Pillay 2004). Placement of these tools also affects whether group members disperse, further affecting whether agonistic events increase or decrease.

Consider: It is logical and judicious to minimize inappropriate and behaviorally costly behaviors (e.g., aggression) and provide a form of environmental enrichment at the same time. All laboratory cats and dogs that can move normally would benefit from the specific interventions discussed above, as did the equally social primate groups.

Zoo Animals

The current mandate for zoo animals actually addresses many of the concerns discussed herein for laboratory dogs and cats (Mallonée and Joslin 2004). Enrichment in zoos includes promoting natural behavior when animals are on display. This may mean including branches or pools, if the animals would use those items in their native habitat. Stress-decreasing devices include visual barriers that allow exhibit mates to have more private time. Despite the extent to which a species is social, there is always a mandate for individual time and space.

Food delivery systems should be used in ways that mimic systems in natural habitats and at time intervals that both mimic the native ones and can be used to provide stimulating activity. Feeders and scents can be placed in varying and numerous areas, with an emphasis on areas the animals are not using routinely. This type of design encourages exploration.

Novelties can be provided as manipula ("toys") or "furniture" and can be incorporated into operant conditioning techniques. The animals people most enjoy watching are the most social and cognitive. Hence, it is incumbent upon zoos to meet the needs attendant with those cognitive characteristics because the animals cannot choose to do so themselves (Burgess and Houts 2004).

Consider: Like zoo animals, laboratory dogs and cats have little control over the social and cognitive stimulation they can choose. Zoos have led the way in purely behavioral enrichment and use of operant conditioning programs that are based on positive reward (e.g., Colahan and Breder 2003; Weiss and Wilson 2003). In part, this direction has resulted because many of the animals (Prescott and Buchanan-Smith 2003; Savastano et al. 2003) with whom zoo staff work would kill the staff members if they were treated with the forceful restraint techniques still common in laboratory cats and dogs. Death and injury can be a useful motivator. Based on this example, we must ask ourselves why we are not using more operant techniques on laboratory cats and dogs, given the overall health and social benefits to the dogs and cats and the time savings to the handlers. All cats and dogs can be clicker-trained to come to the front of their cage, sit, stay, offer a body region for venipuncture, display their abdomen, and so forth. Indeed, this process takes time, but the time would otherwise be spent in alternative ways that would *increase* stress both for the laboratory animals and the personnel handling them.

In terms of commercial breeders of laboratory dogs and cats, operantly conditioned animals collectively constitute a "product" that provides a specific "service" not present in untrained animals. Operantly conditioned and trained animals should command an increased price. Given the direction in which federal regulations are proceeding, it would not be unrealistic to expect that in the future, such behaviors may be required components of the laboratory animal behavioral repertoire.

Conclusion

At a time when we are constrained to focus on behavioral wellness in farm and laboratory animals, we are also being encouraged to consider behavioral wellness in pet animals (Hetts et al. 2004; McMillan 1999, 2002; Reinhardt and Reinhardt 2003). The laboratory concerns for laboratory dogs and cats are truly no different than those for pets, although the factors driving such decisions may differ. Animal welfare concerns, changes in the practice of veterinary medicine, varying international views in an increasingly interactive world, and sheer economics are dictating the exploration of alternative ways to maintain laboratory, farm, and pet animals while enriching their lives (Nolen 2004).

The cost of the changes described herein is not only the tangible but also the intangible cost, and likely it is these intangibles that are most important and least measured. Reducing struggles with research animals reduces man-hours. When animals are trained to work with us, instead of to fear us, we struggle less and are less angry, frustrated, stressed, and distressed ourselves, which enhances worker satisfaction. Working with new techniques, and feeling that you matter in the lives of the animals, also enhances job satisfaction. Working with animals that are easier to handle not only is safer and results in fewer workman's compensation claims, but also prevents job burnout, including increased turnover and financial losses of continual training and replacement. Finally, the quality of data matters, particularly given the fiscal cost of obtaining it. Only by using the most humane methods available can those of us who rely on data from laboratory animals be assured that we are not studying an artifact.

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Selected Web Resources

Assistance for Laboratory Animals

Assistance for laboratory animals that may need improved treatment and care or may be suffering unnecessarily (confidential and secure website of the Animal Welfare Institute): www.labanimalissues.org

Bedding

Durabed; Direct Pet Superstore; 800-360-4838; www.valleyvet.com; Care-A-Lot Pet Supply Warehouse; 800-343-7680; www.carealotpets.com
Folding dog hammock; Orvis; 800-541-3541; www.orvis.com
Guardian Gear™ pet cots; Pet Edge; 800-738-3343; www.petedge.com/beds
Lambs wool mats (synthetic); Care-A-Lot Pet Supply Warehouse; 800-343-7680; www.carealotpets.com
Slumber Pet™ Fleece washable beds; Pet Edge; 800-738-3343; www.petedge.com/beds
Vinyl Foam Mats to reduce back stress for humans and stress on appendicular skeletons in dogs (put at front of runs); The Dog's Outfitter, 800-367-3647; www.dogsoutfitter.com

Enrichment

www.awionline.org/lab_animals/biblio/laball.htm* - database Refinement and Environmental Enrichment for All Laboratory Animals (the 2 contributory data bases - www.awionline.org/lab_animals/biblio/refine.html and www.awionline.org/lab_animals/biblio/enrich.htm - are also maintained; web sites of the Animal Welfare Institute.)

Flooring (Nonslip)/Tiling Sources

Dri Dek® Tiles; Dri-Dek® Tile Roll; The Dog's Outfitter, 800-367-3647; www.dogsoutfitter.com

Head Halters for Dogs

Haltis®, Gentle Leaders™; Dog Wise; www.dogwise.com
Gentle Leaders™; Premier Pet Products; www.premierpet.com

Manipulanda

Buddy group of enrichment food toys: www.premierpet.com
Safe dog enrichment toys (can also be used by various species) by Aussie Dog Toys®, including Tucker balls, Enduro balls, and Home alone: www.aussiedog.com.au

Training

www.apdt.com - The Association of Pet Dog Trainers offers many courses throughout they year on positive training techniques, including operant training, that can be applied to any species.