

Caring Hands

*Discussions by the Laboratory Animal
Refinement & Enrichment Forum
Volume II*

*Edited by Viktor Reinhardt
Animal Welfare Institute*

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Discussions by the Laboratory Animal
Refinement & Enrichment Forum, Volume 2*

Edited by Viktor Reinhardt

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*I am dedicating this book to
the innocent animal behind bars who has to
endure loneliness, boredom and unnecessary distress.*

Table of Contents

Introduction and Acknowledgements i

Chapter 1: Basic Issues

2	Annual Usage of Animals in Biomedical Research
4	Cage Space
10	Inanimate Enrichment
16	Enrichment versus Enhancement
17	Behavioral Problems
22	Mood Swings
24	Radio Music/Talk
29	Construction Noise and Vibration

*Chapter 2: Refinement and
Enrichment for Rodents and Rabbits*

Environmental Enrichment	34
Institutional Standards	35
Foraging Enrichment	36
Investigators' Permission	38
Rats	40
Amazing Social Creatures	40
Are Rats Animals?	43
Petting	45
Mice	48
Signs of Well-Being	48
Petting	51
Shelter and Nesting Material	53
Blood Collection	62
Aggression	66
Barbering	72

Hamsters	75
Aggression	75
Pair Housing	78
Guinea Pigs	79
Group Housing of Males	79
Proper Diet to Prevent Obesity	81
Straw Bedding	83
Rabbits	84
Shelter	84
Enrichment for Single-Caged Rabbits	85
Handling	90
Blood Collection	94
Inappetence	96
Pair Formation of Does	98

Chapter 3: Refinement and Enrichment for Primates

102	Pair Formation and Pair Housing of Macaques
103	Pair Formation
110	Privacy Panel and Grooming-Contact Bars
112	Signs of Partner Compatibility
113	Males
118	Aged Animals
119	Species Differences
120	SIV-Infected Animals
121	Animals with Cranial Implants
122	Census
123	Social Housing of Cynomolgus Macaques
123	Group Formation
126	Group Housing of Males
127	Animals Assigned to Regulatory Toxicology Studies

128	Kindergarten
131	Foraging Enrichment
131	Foraging Enrichment with Standard Food
136	Foraging Devices Made of Cardboard
139	Food Scattered on Drop Pan
140	Colored Food
142	Foraging Substrate for New World Monkeys
144	Popcorn
146	Fruits and Vegetables
151	Foraging Balls
153	Inanimate Enrichment Objects
153	Toys
155	Safety Issues
157	Mirrors
160	Television and Videos
165	Behavioral Problems
165	Poo-Painting
166	Hair-Pulling
170	Stereotypical Locomotion and Self-Injurious Behaviors
173	Husbandry-Related Stressors
173	Double-Tier Caging
177	Changing Housing Arrangement
178	Training to Obtain Cooperation During Procedures
178	Working with Macaques
188	Working with Marmosets
194	Institutional Support of Training Program
196	Spontaneous Cooperation
199	Touching Monkeys
201	Primates in Labs versus Primates in Homes

Chapter 4: Refinement and Enrichment for Other Animals

Dogs	208
Barking	208
Toys	210
Oral Gavage	214
Socialization with Personnel	216
Purpose-Bred Dogs for Research	217
Cats	219
Environmental Enrichment	219
Handling	223
Pigs	226
Socialization with Personnel	226
Blood Collection	228
Social Enrichment	230
Environmental Enrichment	232
Coprophagy	236
Goats	237
Poultry	240

Chapter 5: Miscellaneous

244	Professional Stigma
249	Job Interview
251	Role in Animal Care Committee
253	Killing Animals
257	Death and Dying
258	Self-Awareness
261	Humor

References 267

279 *Photo Credits*

Index 290

Introduction and Acknowledgements

This is the second volume of electronic discussions that took place on the Animal Welfare Institute's Laboratory Animal Refinement & Enrichment Forum (LAREF). This forum was founded in 2002 to serve the international animal care and animal research community for the sharing of first-hand experiences on practical ways how to improve the living and handling conditions of animals kept in research laboratories.

Of 2,866 comments posted between June 2007 and March 2010, a total of 1,912 were selected for this volume. I am grateful to the following animal technicians, animal caretakers, veterinarians, researchers and librarians who contributed these comments: Dawn Abney, Genevieve Andrews-Kelly, Paula Austin, Kate Baker, Jas Barley, Carol Barriere, Sharon Bauer, Vera Baumans, Paula Bazille, Lorrane Bell, Emily Bethell, Eileen Boehle, Louise Buckley, Rebecca Brunelli, Monica Carlson, Jodi Carlson Scholz, Holly Carter, Katie Chace, Lynette Chave, Wendy Clarence, Michele Cunneen, Heidi Denman, Marcie Donnelly, Heather Doviak, Natasha Down, Michel Emond, Thomas Ferrell, Renee Gainer, Joseph Garner, Tamara Godbey, Jennifer Green,

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I have edited and arranged each comment as appropriate, summarized into single comments equivalent content from multiple commenters, and added in brackets editorial clarifications and supportive references from the published literature. Thanks are due to Cathy Liss, Beth Herman, Dave Tilford and my wife, Annie, for thoroughly checking the text for typos and errors.

Attempts to obtain accompanying photos from LAREF members were only moderately successful. Therefore, I have made extensive searches on the Internet and was fortunate in being able to download most of the photos from Flickr, especially under Creative Commons licenses. I am very grateful to the numerous individuals who explicitly or implicitly gave me permission to use their photo material.

My special thanks goes to Ava Rinehart and Cameron Creinin for preparing the layout and creating the design of this book. Their fine sense of harmony gives this book a touch of beauty that I very much appreciate.

This book has been prepared for everybody who is genuinely concerned about the welfare of animals kept in laboratories and for animal rights advocates who don't know that most animal caretakers and technicians, many veterinarians and some researchers do their very best to refine the traditional, often inadequate housing and inhumane handling practices so that the animals experience less distress.

—Viktor Reinhardt
Moderator of LAREF

Mt. Shasta, California
August, 2010

{Chapter 1}

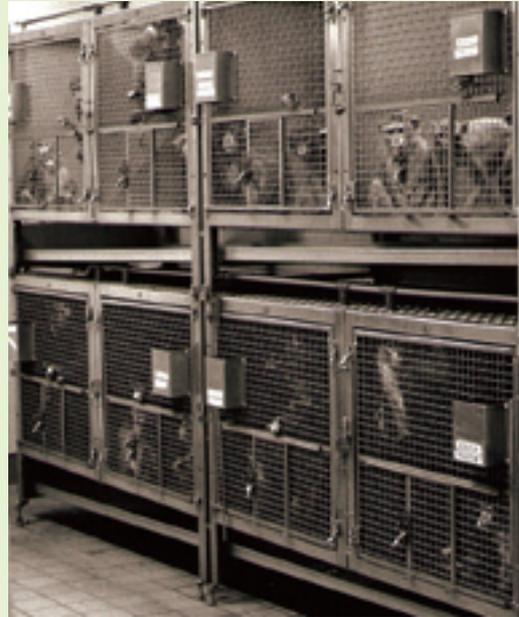
Basic Issues



annual usage of animals in biomedical research

You are probably not surprised that the number of animals used/killed in laboratories is amazingly high. The estimated worldwide annual figure was over 115 million in 2005, according to a recent census (Taylor et al., 2008).

You start wondering if the gradual implementation of the three Rs really reflects a decline of the number of animals used and killed in laboratories, or if we are merely running in circles, blindly believing that we are reducing the suffering of animals kept in research labs.



- I don't think there is any data anywhere in the world that is sufficiently comprehensive to allow us to do anything more than speculate about the number of animals used for research at the moment.
- You are certainly right. Since most animals used/killed annually in research labs all over the globe are not officially counted/registered, we can only speculate about the total number. Yet, there are some pretty accurate counts in some countries of a few species, and if you add them all

up you get well over 1,000,000 animals used and killed every year (Matsuda & Kurosawa, 2002; Richmond, 2002; Gauthier, 2004). Even with the most commonly used animals—mice and rats—excluded, the United States alone uses more than 1,000,000 legally protected, hence registered, animals per year (United States Department of Agriculture, 2007). This number, I think, is high enough to get concerned, and if you care for other creatures, to feel sad.

- I would definitely agree. It's sometimes difficult to change the minds of principal investigators when it comes to decreasing the number of animals per study.
- One of the things one has to bear in mind is that in the U.S.—probably the primary user of animals in research—it is very difficult to get actual figures of rodents used and it is often only an estimate.
- This is not really surprising when you take into account that (a) rats and mice make up the great bulk of all animals used, and that (b) the U.S. is the only country that explicitly excludes rats and mice in its legal definition of the term animal; this implies that rats and mice don't count. They are not covered by the federal animal welfare law (Animal Welfare Act, 2002) and hence are not listed in the official annual reports of animals used in research (United States Department of Agriculture, 2007).

- One also has to take into consideration that the nature of the research has changed significantly from experimental to the breeding-and-killing—for tissues—of transgenic and other genetically modified/mutant animals. I do not know if the United States has even started to count these animals.
- The rising popularity of genetic modification methods has certainly contributed to the overall increase in the number of animals used in research. The number of genetically modified animals used in research has more than doubled in the last ten years (Ormandy et al., 2009).
- I think the issues at hand are not specific distinctions of different animal categories but the huge number of living creatures killed for whatever research-related reason every year. A genetically modified animal is no less a sentient creature who clings to life than a traditional experimental animal.

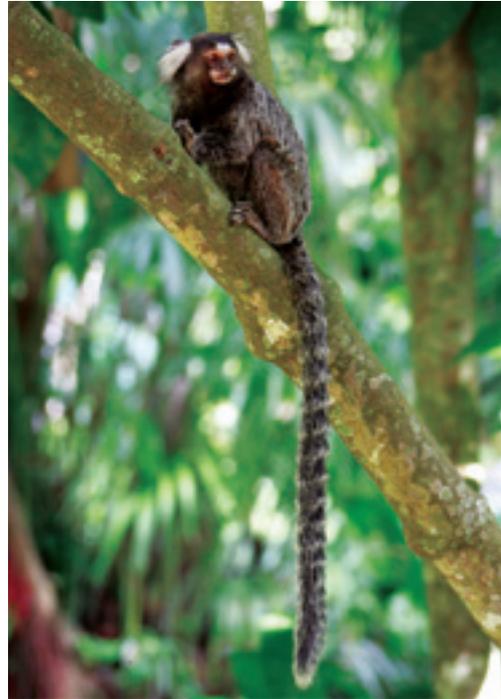


cage space

How can we find out if a caged animal—be he/she a rodent, rabbit, dog, cat or monkey—would benefit from additional space?



- Quite a number of studies have been published, showing quasi-scientifically that the legally prescribed minimum space is sufficient, and that the well-being of the caged subjects would not be enhanced by increasing the cage dimensions. The biomedical research industry, certainly, welcomes such studies. However, their results and conclusions are questionable, if not intentionally biased, because the studies were conducted with unstructured cages (Hite et al., 1977; Bayne & McCully, 1989; Hughes et al., 1989; White et al., 1989; Line et al., 1989, 1990a, 1991; Galef & Durlach, 1993; Galef, 1999; Crockett et al., 1993, 2000; McGlone et al., 2001). I think it is quite obvious that an animal, and for that matter also a human, does not benefit from space per se but from structures in the space. Minimum-sized cages are often so small that you cannot provide species-appropriate structures unless you increase the vertical and/or horizontal space.
- It is hard to believe that animals don't benefit from additional space. I wish I had additional vertical space for my marmosets. I truly believe they would benefit from it.



- They probably would, but only if you have placed branches or other structures in the additional vertical space. Those structures would be necessary to make the additional vertical space accessible for your marmosets; they cannot possibly perch in empty vertical space, they need some kind of structure to climb and sit on in the additional space.



- Beyond minimal requirements for species-typical body postures and adjustments and species-typical movements patterns, empty space has little value for animals and humans alike; in fact unstructured space induces anxiety [Fredericson, 1953; White et al., 1989; Forkman et al., 2007; Kallai et al., 2007; Lamprea et al., 2008]. Individuals therefore have the tendency to shun open space but keep at the periphery close to the only structure available: the wall or the fence and corners. This behavioral and emotional response to open space is termed wall-seeking or thigmotaxis [moving towards an object and keeping contact/touch with that object].



- The classic Open-Field test [Hall & Ballachey, 1932] is based on this natural tendency of rodents to avoid entering and crossing an anxiogenic area that lacks structures that would protect them from potential predators or raptors.
- I know that elephants can hardly be called a laboratory species, but we recently recorded a statistically significant positive correlation between the gait of zoo elephants and enclosure size: elephants with larger enclosures had more elephant-characteristic extended gaits.
- Your observation is not surprising. You will probably find the same phenomenon in human prisoners kept in very small single-cells. My question relates to all captive animals; so your elephants fit perfectly.
- I have heard—but have no personal experience—of laboratory rabbits breaking their backs when they try to hop normally after being released from cages. Presumably this would be prevented if the rabbits were given large enough enclosures to hop normally and develop a stronger musculo-skeletal system. This type of evidence indicates that for best welfare, the amount of space per se can be important, and it is not necessarily always related to what that space includes.

- Birgit Drescher did studies on bone density in rabbits in the early 1990s and found that bone thinning developed in rabbits confined in small cages for about five weeks [Drescher & Loeffler, 1991; Rothfritz et al., 1992]. The bone thinning was reversible once the animals were placed in pens allowing normal movement. Birgit Drescher's comments to me were: "When you take a rabbit out of a cage and let it run in a pen that allows all movements, it will get physiologically normal and strong bones at any age."
- I experienced this several years ago when I tried to take rabbits out of cages and placed them in a pen. The sentinel rabbit stamped his foot and broke his leg due to osteoporosis.
- I would conclude from this that single-caged rabbits, such as bucks who don't get along with each other, really need rabbit runs—like small dog runs—so as to be able to hop properly and thereby maintaining healthy, strong bones.
- It is not uncommon for adult macaques who, after having lived in small unstructured cages for many years, sprain a joint or break a limb when they are released into a large enclosure. There are people who quote such incidents, arguing that monkeys do not benefit from larger cages.
- We never had animals break a limb or seriously injure themselves, but we did see a lot of very interesting locomotor patterns when some of the monks, donated to my last facility, were released to an outdoor pen instead of a cage. They performed a lot of hopping/bucking, like a horse, and had issues with judging distance when jumping between perches. Many of the monks missed perches and/or sides of the pen when jumping toward them. After about a week, everyone usually figured out jumping and walking in monkey fashion.

I was always wondering, do the monkeys lose depth perception over time when they do not need it, because there are no structures in their environment, or were all these animals near/far-sighted to begin with?
- You raise a potentially serious issue. Most of us tend to think that the retina and visual pathways develop normally under most circumstances. However, this is not necessarily true when the living environment is not normal. In writing a chapter on the welfare of laboratory rodents, I have found two papers indicating that retinal functional development and visual acuity in rodents can be improved by environmental enrichment (Prusky et al., 2002; Landi et al., 2007). So, rearing animals in standard, non-enriched, laboratory-cage conditions could mean that these animals have less effective eyesight. My feeling is that, because primates are generally more visually oriented than rodents, this could have even more serious consequences for your monkeys.

Legal minimum cage space requirements are usually based on body weight. How appropriate, from the caged subject's point of view, are such stipulations?

- Legal minimum space requirements should be tailored in such a way that species-specific and species-adequate furniture can be placed in the enclosure without blocking part of the space that the occupant(s) need for free movement and free postural adjustments. I see no difficulty that would hinder experts from coming up with prescriptions of basic furniture for each species, for example shelters for rodents and amphibians and elevated resting surfaces for birds, cats, dogs, rabbits, and nonhuman primates.
- One factor that is important but is consistently overlooked is age. Very young animals need far more space than heavy or obese ones!



- Yes, juveniles need to have more space than adults, let alone adults who are overweight. Young animals are much more active and typically want to play; to do that, they need extra space. Most countries, including the U.S. [United States Department of Agriculture, 2002a], do not take this into account in their legal minimum space stipulations for caged animals.
- In the revised Appendix A of the Council of Europe, minimum floor area is now not only based on body weight, but it also takes into account the need for young animals to play [Council of Europe, 2006]. For example, for mice, the minimum floor area is 330 cm² per mouse, independent of the animal's body weight; this means that young and small, but relatively active mice grow more or less into their cage. Furthermore, the cage must be structured and provided with enrichment; examples are given for each species.
- It may not be enough to stipulate that enrichment must be provided and then list some options. We have this situation here in the U.S. with the Animal Welfare Regulations. To take an example: you do comply with these regulations if you give a single-caged monkey a mirror, but otherwise do not structure the space, for example, with a high perch. Both the perch and the mirror are



listed as possibilities of environmental enrichment [United States Department of Agriculture, 2002a], leaving it up to you to pick and choose.

It does not seem appropriate to lump everything together under the term environmental enrichment. There are things that are biological necessities, such as elevated areas for primates, so they should be legally mandated, while other things such as mirrors may be enriching, hence can be optional.

- That is true; when only the *necessities*, such as nesting material for mice, shelter for rats, social contact for social animals, high perches for nonhuman primates, etc. are listed as examples of environmental enrichment, there is no option to get away with enrichment for which the animal has no real need, for example toys or mirrors. I saw little play balls for mice, as if mice would need those to express mouse-typical behavior patterns.

inanimate enrichment

Most animals quickly lose interest in inanimate objects that have no survival value. At what interval do you rotate enrichment devices to create a novelty effect so that the animals show renewed interest in them?

- In facilities with large numbers of rodents, rotation of enrichment gadgets becomes part of the cage changing routine, that means about every ten days. To exchange the gadgets more frequently would not be practical; it would also not be good for bio-security to open 1,000 or more ventilated cages two or three times a week.
- At my primate center, the enrichment devices are rotated on a two-week on, two-week off schedule.
- At our facility, we rotate enrichment objects and foraging devices for caged primates on a weekly basis. A device is given for two days per week and then



removed. Currently there are five different feeding devices and six different non-feeding devices used regularly in our rotation. Our animals usually do not see the same device more than once every 2-3 months.

- We have an enrichment tech who develops a calendar for the animal care staff to replace different toys on a two-week rotation when the cages are changed. All monkeys of the same room have the same toy. In addition to the toy, every two weeks each monkey gets access to a different in-house made foraging device, each for the duration of the two-week interval.
- In my experience, there is one toy that rhesus macaques never seem to lose interest in. I hang paint rollers on the outside of the cages and smear peanut butter or honey on them once every day; it takes the monkeys a long time to pick every morsel of the sticky food stuff off the rollers. Since the animals show no signs of habituation, we do not need to rotate these gadgets.
- Gnawing sticks are also enrichment objects in which macaques do not lose interest over time. The sticks are changing their form and texture due to wear and dehydration, thereby retaining a kind of novelty effect. You don't need to rotate these branch segments, but simply exchange them with new ones when they have become so small that they fall through the mesh

floor of the cage. The nice thing with these natural toys is that they are inexpensive; you can actually cut them yourself from dead deciduous trees. I have done that while working at a primate research center and provided attractive environmental enrichment for more than 700 caged rhesus and stump-tailed macaques at no cost.



- That's the way to go! Doesn't it make much more sense to come up with some kind of enrichment in which the animals do not lose interest over time, rather than investing money and time to buy an assortment of enrichment objects with short-lived novelty effect and rotate them on a regular basis? I think what is true for nonhuman primates is also true for rodents, rabbits, dogs, cats and birds: effective enrichment is much more reasonable than rotational enrichment.

- In my opinion, enrichment should at least focus on species-specific behavioral needs. Toys generally don't do that, which might be the reason why the animals lose interest in them quickly. Experience has shown that the provisions shown here remain attractive for a very long time, probably because they address species-specific needs.



Shelter, gnawing and climbing possibilities for rats



Nesting material for mice



Shelter and nesting material for hamsters

Shelters and hay for guinea pigs





Straw and hay for pigs



*Social companions for mice, rats,
guinea pigs, hamsters, pigs,
monkeys, dogs and cats*

- It seems also to me that biologically relevant environmental enrichment intrinsically bears a quality of lasting novelty that most dead enrichment objects are lacking. For example, depending on the species, animals don't get bored from:
 - (a) working for food (e.g. food puzzles),
 - (b) searching for food (e.g. food mixed with woodchips),
 - (c) processing vegetables/fruits,
 - (d) gnawing wood,
 - (e) interacting with a companion,
 - (f) maintaining a species-adequate nest/shelter,
 - (g) bathing in sand,
 - (h) looking out from a platform/shelf/perch, and
 - (i) looking through a window.

These activities in themselves are biologically important, plus the enrichment object is dynamic or provides entertainment. In a way, such enrichment is not really enrichment. It is a necessity, and as such should be a basic standard provision in the captive setting.

- I could not agree with you more! The word enrichment is often misleading, making us think we are doing something as a luxury for an animal, when in fact it is often essential for the animal's welfare.

Are running wheels for rodents a necessity or enrichment?

- I see a running wheel as a necessity for caged hamsters and caged mice, because it allows them to release the biologically inherent drive for moving around; I am not an expert, but I would assume that in their natural habitat many rodents travel quite a distance within the area of their home territory in the course of a day. The running wheel is not a natural structure, but it promotes the expression of a behavioral drive that could otherwise find little release other than stereotypical movements. I am not sure what the situation would be for rats.

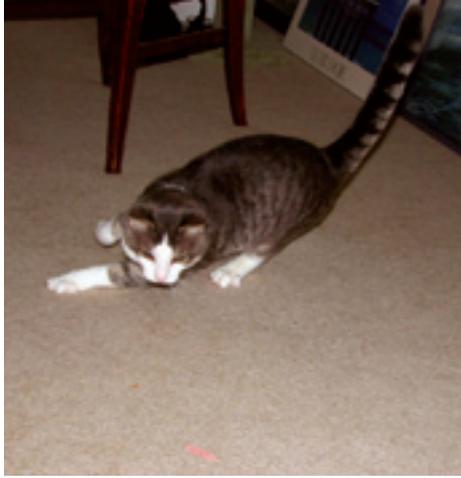


- I think running wheels should be in the necessity category.

I have had researchers who do exercise studies, and both mice and rats would run over 10 km a night. I was quite surprised at the distances covered by these little guys.

- When I wrote a review on wheel running, I found that the distance run in 24 h by animals in a running wheel can be as great as:
43 km for rats (Richter, 1927),
31 km for wild mice (Kavanau, 1967),
16 km for laboratory mice (Festing & Greenwood, 1976),
9 km for golden hamsters (Richards, 1966),
and
8 km for Mongolian gerbils (Roper, 1976).
- I would infer from this that rodents have a strong biological need to move their legs over considerable distances. In the artificial cage environment, a running wheel becomes a necessity because it helps them satisfy this need.



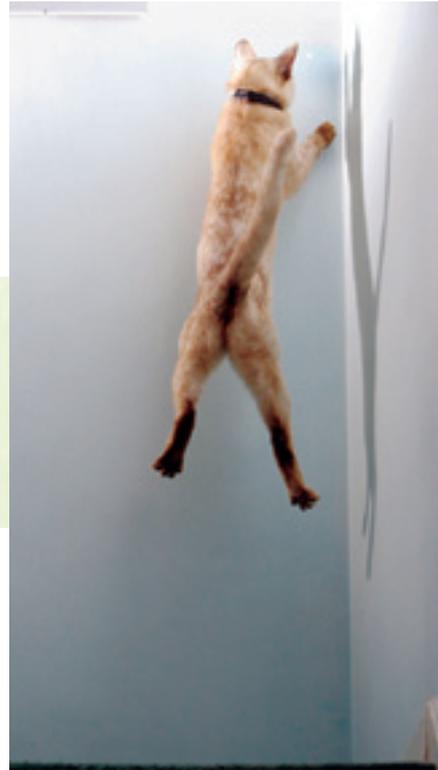


Do you use laser pointers as an enrichment tool for animals in your charge?

- One of our ideas is to use a laser pointer to train rhesus macaques targeting to an area that we cannot reach with a traditional target (e.g. a lixit in the back of the cage). We have exposed the monkeys to the laser, just to gauge their reactions. Some of them are interested, some of them don't care, and some of them are fearful at first.

I have used a laser pointer with our house cat; she absolutely loves to chase it, and never gets tired of it. It's amazing how high on the wall she'll jump trying to catch the light dot!

- I have used a laser pointer with cats, both at home and in the lab. They love it! Having tried a few different varieties, I've found that they don't seem to care what shape or what color the light reflection is, just as long as it keeps moving.



- Laser pointers work very well for cats living in relatively large quarters. To have them chase after the light dot provides species-adequate environmental enrichment for the cats and for the personnel. It's real fun!

Unfortunately, the laser pointer gets useless when you are dealing with single-caged cats. There is just not enough space for chasing after a target.

- Laser pointers also provide great enrichment for hens.

enrichment versus enhancement

When we refine the living quarters of animals do we enhance or do we enrich their environment?

- U.S. Animal Welfare Regulations use the terms environmental *enhancement* and environmental *enrichment* in their specifications for nonhuman primates. These regulations do not define either of the two terms; environmental enhancement is not used as a synonym for environmental enrichment, but environmental enhancement includes environmental enrichment along with social grouping and restraint devices (United States Department of Agriculture, 1995).
- Environmental enrichment seems to still be the standard term; I always use it as a key word. In text, however, I use something more specific and accurate such as the name of the actual physical change being assessed.
- The term environmental enrichment will still have to be used as a keyword as long as it is the preferred term in the lab animal world.
- When checking the literature it becomes clear that environmental enrichment is the most commonly used term. Why? Probably not because of a preference; I guess people have simply become used to it, without actually questioning its practical value, and the word enrichment has a positive connotation in the public domain.
- We have discussed these terms already. There was a general consensus that *enrichment* may be somewhat misleading when we provision the barren living quarters of captive animals with conditions—furniture, social partners—for the expression of basic behavioral needs, such as foraging, social interaction, seeking shelter, building a nest, or retreating to an elevated refuge area. When we do this, we are not really enriching the environment of the animals but we are addressing basic necessities for their behavioral and emotional health.

We may enrich a rat cage that is already furnished in species-appropriate ways by adding a toy or some other entertaining gadget. But we do not enrich a barren rat cage by adding a suitable shelter.
- To add some resources to a barren cage is over-egging it when calling it enrichment; hence *enhancement*, to make it slightly better.



behavioral problems

Are caged animals in research facilities showing abnormal behaviors, or are their living quarters in which they live abnormal, hence determining the animals' behavioral expressions?

- Animals in captivity often exhibit behaviors that they do not show in their biologically natural environment. We label such behaviors as abnormal and invest a lot of resources to eliminate them, even though evidence has shown that this is a rather futile endeavor, and stubbornly—and perhaps even intentionally—overlook the fact that it is not the animals' behavior that is abnormal but the human-created, species-inadequate living quarters to which the animals try to adapt but often fail. If we would design more normal, that means species-adequate living quarters, there would be no cause for abnormal behaviors.
- At our facility, we avoid the term abnormal behavior because what is normal behavior in captivity does not necessarily correspond with the behavior in the wild. Behaviors

are bound to change in an artificial, captive environment. We use the term aberrant for behaviors—such as SIB [self-injurious biting]—that we regard as behavioral problems and hence need to be addressed for animal welfare and/or scientific reasons.

- It seems to me that an animal's attempt to somehow adapt to species-inadequate living quarters are intrinsically normal even if the corresponding behavior appears to be abnormal.
- If a behavior does not normally appear in the ethogram of an animal, then when it is expressed it must be abnormal. If we start describing or accepting abnormal behaviors, such as self-biting or hair-pulling as normal, we give people an excuse to continue housing animals in the conditions that are causing these behaviors.
- Even if the behavioral adaptation is unsuccessful—for example self-mutilation—and looks abnormal from the human point of view, it is certainly not the animal's fault. The animal's response to the given situation—being forced to permanently live in a small and boring cage—is, in my opinion, biologically normal. This doesn't imply that we can accept the inadequate, human-created living conditions that are responsible for the animals' unsuccessful adaptation attempts.

- I would not call self-biting and hair-pulling normal behaviors either; they are most definitively harmful. But sometimes I wonder about stereotypical circling and pacing. The animal is confined in a much too small space, what else can he or she do to burn energy and get exercise, but move in a rather restricted manner. I would call this an *adaptive* behavior; adaptive to the small cage.

I would most certainly pace back and forth or run in a circle over and over again if I were forced to live in my little bathroom for most of my life; I would do this, just to do something, trying not to go crazy.

- I very much agree with your observation and would also label stereotypical locomotions and movement patterns, such as pacing, somersaulting, circling, rocking, swinging and bouncing as adaptive behaviors. As you point out, what would we do if we were locked permanently in a small unstructured room? The biological drive to move cannot be disregarded; it somehow has to be expressed in action. However, we would have to make a clear distinction between adaptive [non-injurious/harming] behaviors and maladaptive [injurious/harmful] behaviors:
 - (a) self-biting leading to no visible tissue damage would be an *adaptive* behavior, while
 - (b) self-biting leading to open injuries would be a *maladaptive* behavior.

- I worry that the term adaptive behavior may be misused as a caveat for decreased concern over animal well-being, since it could then be argued that animals do adapt to any living quarters even if these disregard their behavioral needs.
- There are quite a number of quasi-abnormal behaviors that are not an animal well-being concern for me. Repetitive locomotion and movement patterns are probably unavoidable whenever we place an animal—including a human—into a cage. I see those activities as biological healthy attempts to adapt/adjust to artificial, enforced

living quarters; the subject *must* somehow express the drive to make use of the legs, even if this implies running in circles, bouncing up and down, or back-flipping. Even in zoos, where animals have much more living space compared to animals in laboratories, repetitive locomotions and movement patterns are not uncommon. I want to argue that we cannot avoid that animals in laboratories develop such stereotypical locomotions; and I would also argue that such activities are not detrimental to the subject.



- It is not unusual that animals and humans develop bizarre, repetitive behavior patterns when they are bored for a long time. Being confined in a more or less barren cage/room is probably such a situation in which parts of one's own body serve to provide some minimum stimulation for the mind. I would categorize such boredom-triggered behaviors not as abnormal but rather as normal attempts to cope with a biologically abnormal environment.
- If an animal develops an abnormal behavior that is causing injury or any other physical or psychological harm, then I would say that the animal cannot properly adapt/adjust to the human-created living quarters. I would classify such a self-destructive activity as *maladaptive* behavior and argue that we have not only an ethical but also a scientific obligation to change the animal's artificial living environment in such a way that (a) the behavior stops completely, or (b) does not show up in any other animal raised and kept in the refined living environment.

I think we could help laboratory animals more effectively by focusing our effort to *prevent* maladaptive behaviors such as self-mutilation rather than engaging in the futile attempt to stop/eradicate normal adaptive behaviors, such as stereotypical pacing or running in circles.
- I prefer the terms captive or adaptive behavior rather than abnormal behavior, but it will probably not make a difference to the animal what term we humans use.
- Terminology does matter, at least indirectly, to the animals because words reflect human feelings/attitudes. When we say, *an animal shows abnormal behaviors*, we make the animal quasi-responsible for behaving in an undesired manner; something is wrong with the animal, so we try to correct this behavior or make the animal stop showing it. When we do this, we are shifting the responsibility for the problem onto the animal, tacitly disregarding the fact that we—not the animal—created enforced, species-inadequate living quarters that make the animal behave in a strange manner. We—not the animal—created the problem, so it is up to us to fix it!
- The word *vice* used by farmers for stereotypies such as bar-sucking, tail-biting and crib-biting is probably the equivalent to the term abnormal behavior used by laboratory animal scientists.
- In order to have a vice you have to be responsible for your actions, i.e. be a moral agent, hence Aristotle's *vice and virtues*. When we say, *animals show a vice or engage in an abnormal behavior*, we implicitly suggest that they are carrying out

these behaviors deliberately to frustrate their owners; crib-biting in horses means destroying the beautiful feeding trough that has been given to them. Unfortunately, these terms are often used as if it were the animals' fault to engage in these behaviors that are seen as "undesirable" [e.g. Poffe et al., 1995; Sodaro & Mellen, 1997; Boinski et al., 1999; Lukas et al., 1999; Iglesias & Gil-Burman, 2002].

- It seems to me that both terms—vice and abnormal behavior—imply that something is wrong with animals who show certain activities that are not accepted by their owners.

We use this kind of fault-finding language not only with animals but also with humans. For example, when a child gets engrossed in stereotypical hair-pulling or nail-biting while doing homework, the parents are tempted to let the child know that it should stop pulling the hair or biting the nails; they may—and often do—even punish the child for behaving abnormally, that means not like a *normal* child; so the child gets the message, *something is wrong with me, I am a bad kid*.

Personally, I think, it would be fair of the parents to ask themselves first, "why does our child show this bizarre behavior? Do we, perhaps, overwhelm the child with our selfish expectations of him or her in school?" Most parents don't ask such



sobering yet honest questions. In the end, the child's "abnormality" may have its origin in the parents and not in the child; that would be a completely different story!

Before we claim that a mouse or a monkey shows an abnormal behavior in the laboratory cage, should we perhaps not first ask ourselves, "when we designed the animals' living quarters, did we fail to consider something that is now making the animals behave in a way that they would never do in the wild?" We may find that what is abnormal is perhaps not the animals' behavior—attempts to adapt/adjust—but the inadequate living quarters that we have created and now force the animals to live in.

mood swings

We sometimes feel great, relaxed, outgoing and happy, at other times sad, frustrated, depressed, tense, or impatient. I wonder, do the animals we are working with on a daily basis pick up these mood swings and respond to them physiologically and behaviorally?



- Studying the effects of stress on how rhesus macaques interpret signals in their environment, I think it is possible that monkeys who have a trust-based relationship with people are sensitive to the factors you suggest. However, I suspect most monkeys housed in laboratories do not have the opportunity to develop such relationships with the attending staff so that they could pick up on these subtle emotional signals.

My own research suggests that the way in which monkeys interpret and respond to ambiguous signals varies with the monkeys' own stress levels. For example, following a routine but stressful veterinary examination, monkeys demonstrate a reduced expectation of positive events associated with ambiguous stimuli. In less stressful situations, monkeys demonstrate an increased expectation of positive events associated with the same ambiguous stimuli.

If we were to extrapolate from these experimental findings and take caretaker mood signals as our ambiguous stimuli, then it is reasonable to assume that interpretation of our mood signals

depends on whether or not a monkey feels at ease or stressed. In other words, depressed or stressed monkeys may be more likely to interpret our behavior and expressions as more threatening, regardless of our actual mood. Being stressed creates more stressors! This produces a negative cycle that inevitably leads to depression, despair and illness. This may well be very similar to our own experiences of bad moods or depression, where we interpret otherwise ambiguous events as worrisome or threatening—paranoia being an extreme example.

- Dogs certainly are sensitive to our moods. They very quickly pick up changes, especially visual ones, like a sad or angry face or a depressed body posture. They definitely know the difference between an angry voice and a happy voice. The instant a smile crosses a person's face, a familiar dog will gleefully wag his or her tail.
- You don't need to raise your voice when scolding a dog; your mere look is sufficient to make the dog feel uncomfortable and ready to be forgiven.
- When I am entering a monkey room in a bad mood, rhesus macaques respond to me in such a way that I believe they do sense my emotional energy and respond correspondingly in a rather reserved, apprehensive manner.



- I find it fascinating to experience over and over again how spontaneously and correctly animals—like monkeys, cats, dogs, deer, cattle, buffalo and birds—not only understand what's going on in the human psyche, but also in the human mind. It's a communication beyond words, so there is very little risk of misunderstanding. If you pretend to feel a certain way, the animal will know that you are cheating and will respond accordingly, but you can always be assured that the animal behaves and expresses feelings authentically. The same principles hold true when you interact with human infants who have not yet learned how to play social roles to their own advantage.

radio music/talk



Animals in laboratories are often exposed to radio music/talk while attending personnel are in their rooms or, all day long, while the radio is on in the hallways. No doubt, radio music/talk may help to keep personnel in a good mood, which may reflect in a relatively better performance of their routine work. What about the animals? People do show aversive reactions when they are exposed to radio music/talk that they don't like or that is too loud. They can protest or simply leave; caged animals do not have this option even though the radio music/talk may also be a nuisance (stressor) for them at times.



When your animals are exposed to radio music/talk, what tells you that they are not bothered by it or, even better, that they actually like the radio music/talk?

- The dogs and cats we are working with do not seem to be bothered by music. Coming from animal shelters, they were originally probably in homes and, therefore, used to the sounds of radio and TV. Hearing these familiar sounds may have a calming effect on them. Whether they actually enjoy the sound of music is hard to say.
- I would argue that radio/TV music and talk should be allowed in rooms of research-assigned animals only if it has been documented that the music/talk does not disturb the animals, i.e. constitute a variable that has the potential of influencing research data. Choice tests along with behavioral observations should readily clarify this question.
- I play classical music (CDs) in our dog rooms. It is difficult to say if the music makes a difference for the dogs, but I enjoy it and feel calmer!



- Some time ago we exposed mice to pop music, a Mozart symphony, New Age music or no music and scored telemetrically the animals' heart rate, body temperature and activity and recorded manually their behavior. We found no significant difference between all types of music and no music and concluded that music did not make a difference for mice. However, as the attending animal care staff liked listening to music during their working hours, their feeling good might indirectly have affected the well-being of the animals in their custody in a positive way.
- AAALAC once toured a facility where heavy metal played at full volume all day and night. When the site visitors came in, they frowned visibly and suggested this was too stressful a type of music for a transgenic core facility. I indicated the music was IACUC [Institutional Animal Care and Use Committee] approved and they would have to discuss the music choice with the PI [Principal Investigator], as it was his preferred music. When they asked him, he went on for 20 minutes elaborating about the virtues of the loud music to cover the elevator machine room that was right next door.
- It is my experience that rabbits in rooms with low-volume music are much less startled when humans enter the room. Many breeding colonies of mice need

music to mellow out the background noises in order to achieve more consistent birth rates.

- I believe the single most important, influential variable in the housing room of any mammal or bird is the human caretaker. We influence the animal by the way we smell, body language and other vibes we humans can't even figure out. Anything that makes us happier makes us give off better vibes and the animals are less stressed and consequently will give better research results. When I am in a good mood, the animals in the room will reflect this in their behavior; they will be relaxed, calm and curious about their surroundings. When I am in a bad mood, they will be restless, alert and reserved when I approach them.

If I like hip hop music, but the facility says only classical can be played, I may be in the room hating what I am listening to; my feeling of frustration may affect the animals negatively thereby overriding any positive noise-masking effect of the classical music. Conversely, if I enjoy listening to the music, I will probably radiate positive energy that will affect the animals in a positive, perhaps anxiety-buffering manner.

So, I think you should be allowed to play your favorite music when you are in your animal rooms, but you need to keep the volume at a level that allows you to talk over it if you need to communicate with someone in the room.

- As long as the animals are not exposed to repeated noise—for example their room is located right beside the elevator machine room—the reason for the music is to keep us caretakers or animal technicians in a good mood; after all we humans are potential predators, hence serious stressors for the animals. When the animals are alone, there is no need to keep a radio on. I am not sure if music per se is of any benefit to the animals.

- We used to have radios turned on in our marmoset rooms. After finding out that marmosets, when given the choice, prefer silence over any kind of music (McDermott & Hauser, 2007) we decided to turn all the radios off. There was some concern that the marmosets would be more nervous during any kind of disturbance, but this was not the case. When there was silence, the animals showed no conspicuous alarm reactions when people were talking in the hallways or someone entered their room.

We now turn the radio on for short time periods only (a) when we expect a sudden noise which might upset the animals, or (b) when a technician is working in the room (to keep the technician happy).

- That marmosets prefer silence to radio is not at all surprising when considering the fact that 30-minute exposure to playing radio is enough to double their salivary

cortisol concentration (Pines et al., 2004); it's obviously stressful for them when they have to listen to the radio.

- Audio plays for our cynomolgus macaques all day long. We have a mix of music that is played, from soft jazz to waterfall sounds and instrumental. The volume is set at a specific level, but in each room there are dials to turn the music down or off when a function is accruing or the television is playing. I do see calmer primates—both attending human primates and nonhuman primates—when the softer music or instrumental music is playing.

We'd had some harder type classic rock songs that were taken off the list, because they made some monkeys very agitated, especially when the volume of the sound was turned up too much.

- We use radios in the study room for as long as the study lasts. In the housing rooms, we have the radio play music one hour in the morning and again one hour in the afternoon. The rhesus monkeys and the marmosets seem to enjoy listening to music from the 60s, 70s, Disney music, and also nature sounds. I have the impression that the music has a calming effect on the animals.
- It is my personal experience that music in animal quarters does not necessarily make all humans who are exposed to it happy.

Some people like loud rock music, others like soft background music, while others prefer silence. I would assume that animals also do not always share the musical taste of the attending care staff and, perhaps would chose silence if they could.

- I have found in most primate research facilities I have worked and visited (a) that radios or TVs are the main aspect of their enrichment plan and (b) that the animals are generally stressed by people. Often the only contact they have is under stressful situations such as health checks, dosing and sample collection. Unless a great deal of effort has been made to acclimate the animals to research procedures and human interaction, they are typically fearful and defensive-aggressive in our presence.

The animals can neither control the volume nor the content of the sound that is emitted by the radio. Typically, the attending person listens to programs with people singing or talking. If the animals already find humans stressful, how *enriching* can it actually be for them when they are exposed for hours on end, against their will, to human voices from the radio?

- It is questionable that nonhuman primates, and for that matter any animal species, like radio talk and music as their caretakers do. Being confined in a cage,

not able to escape the source of loud and possibly disturbing music and human talk can probably be quite distressing for them. After all, what is *music* for the human ear is most likely *noise* for the animal ear, and if that's the case it is most likely a source of stress [Barrett & Stockham, 1996; Jain & Baldwin, 2003; Pines et al., 2004; Campo et al., 2005; Burwell & Baldwin, 2006; Baldwin et al., 2007; Naff et al., 2007; Turner et al., 2007].

- I know of one unpublished study in which chimps were given a control box that allowed them to turn the music on and off. Perhaps not surprisingly, the chimps usually chose to turn the music off just like the marmosets of the already mentioned study by McDermott and Hauser (2007).
- It is worth remembering that animals have very different hearing ranges than humans, for whom we have designed radios and speakers. This subject really is one for asking the animals themselves in terms of types of noise/music and the volumes, because they also have very different frequency sensitivities; so, what humans might find comfortable and pleasing, other species might experience as noisy and unpleasant.

construction noise and vibration

Do you think that the animals in your charge get stressed when construction takes place in or near the animal holding facility?

- I can share some anecdotal evidence of effects of construction noise on the animals from my previous employer. While analyzing a rat adjuvance arthritis study, we found a significant and unexplained dip in body weight on one day, followed by immediate recovery over the next two days in all of our rats. When we asked the animal unit whether anything extraordinary had happened with our animals that day, they told us that the previous day, a large PET [Positron Emission Tomography] scan needed to be installed in the building, and one side wall of the building had been opened. All researchers performing behavioral studies were warned in advance, but they did not think it would affect any of the other studies!

So, yes, I strongly believe that construction noise can stress animals. They might get used to it when it goes on for a while, though I am not sure about that.



- Yes, I do believe that animals become stressed by construction noise.
We recently had our cage wash outfitted with new tunnel washers. During that time, our nonhuman primates became extremely stressed and agitated. The monkeys alarm-called a lot during

the day while construction was going on and many of them developed stereotypies that were not observed previously, like swaying back and forth and charging their own reflections. Others who had already displayed stereotypies—like hair-pulling—before the construction started, increased these behavioral disorders, and some even began self-biting after the construction got underway. We did our best to alleviate their stress and entertained them during the day by providing extra enrichment items like foraging boards and puzzle feeders.

The construction went on for several months during the summer, and I have to say that our primates did not adjust over time. Even after the construction was completed and the noise finally stopped, some monkeys continued with their new stereotypies.

Also, our canine colony seemed very distracted during the construction months. The dogs were much more vocal and less focused during their training sessions; however, they appeared to gradually get used to the noise. Towards the end of the construction, they were again more focused and less vocal.

I should note that the cage-wash area is located on an adjacent wall to both our dog rooms/runs and also our primate suites. These two groups of animals received the brunt of the noise from the construction compared to the other species located farther away.

- The cynomolgus macaques I have worked with did not adapt to construction noise;

they always became and remained conspicuously more reactive and vigilant during periods of loud construction activities.

- I have made the same observations in rhesus macaques. While the construction noise was dragging on for weeks, the animals were much more reactive and restless. I had to stop training them on workdays because they were always on the alert and very distracted; their responses to me were no longer reliable, so the interaction became unsafe.
- We had a lot of noise going on over the last couple of months during construction of a new outdoor monkey area with a swimming pool, as well as a new indoor building for the monkeys. The new digs were built about 30 feet behind the existing facility, so the animals could see and hear everything that was going on.

The rhesus monkeys were stressed out during the first couple of weeks, but their stress levels decreased gradually as they became accustomed to the project. I knew they were stressed out at the first stage of construction, when I observed a lot of pacing, out of character screaming, fear grimacing, even leg-biting and arm-biting—behaviors that these monkeys had never shown while they were in my care. So, during the first couple of weeks, I stayed with them in the indoor area for reassurance; I played some of their favorite movies with the volume up quite high to drown out the sound of construction. The

only thing that remained an unwavering stressor was when the concrete trucks arrived. The trucks made a loud beeping noise as they were backing up; the monkeys never became used to that. So during concrete delivery we locked the animals indoors until the trucks were gone. I handed out treats and gave a lot of reassurance during that time. They could still hear the trucks and the beeping, but at least this extreme noise was somewhat muffled.

In summary, I would certainly say that yes, construction activity can be a serious stressor for captive macaques.

- Pines et al. (2004) found that marmosets do not necessarily show any stress-indicative behaviors when they are exposed to loud construction noise even though they experience a physiological stress response as measured in a significant increase of saliva cortisol levels.
- We have been in the middle of construction pretty much constantly for the past ten years. Most of the noise had little noticeable consequence, however, when a classroom building was built across the street from us, the ground was first tamped for three weeks and then pilings were driven for another three weeks. For six weeks the ground vibrated constantly for eight hours a day! We lost at least six months' worth of breeding of the transgenic mice; even the zebra fish stopped laying eggs. Unfortunately we did not have anywhere to move the animals within the facility to shield them from the commotion.
- As an institution we have experienced quite a bit of growth in the past few years. Some animals, particularly mice, rabbits and bushbabies become obviously stressed. The disturbance associated with the construction range from loud noise to strong vibrations felt through the walls and floor. This appears to affect our animals' reproductive cycles and performance. Fewer litters are born and there is more evidence of cannibalism during times of loud construction activities.
- Rasmussen et al. (2009) noted in mice that construction noise decreases reproductive efficiency by decreasing live birth rates.
- Typically, new construction and renovation of facilities are long-term projects that can create an extraneous variable. This is often overlooked because it seems unavoidable. I would assume that construction activities are not only stressors to the animals and the personnel, but the animals' physiological response to them will make any scientific data obtained from them questionable if not altogether useless. Yes, you can install/place noise-buffers, but they are not 100 percent effective and they have no impact on vibrations caused by construction; in addition, most institutions are unlikely to invest extra money to shield animals from stress caused by construction because they are already spending so much money on renovation and new construction. Seems to be a pretty hopeless, extremely counterproductive situation in many facilities.

{Chapter 2}

Refinement and Enrichment for Rodents and Rabbits

