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THE Enrichment RECORD

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Environmental Enrichment and the Laboratory Zebrafish

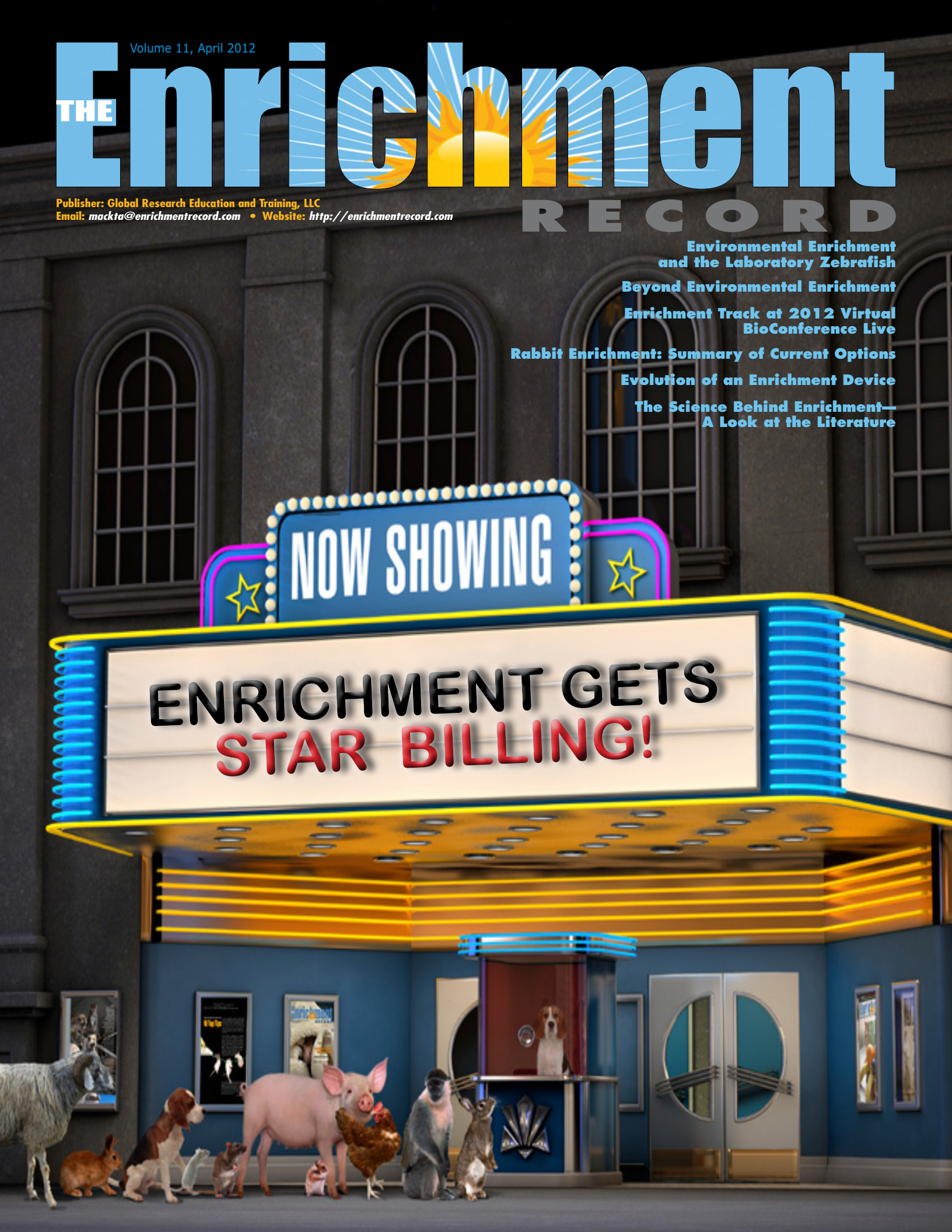
Beyond Environmental Enrichment

Enrichment Track at 2012 Virtual BioConference Live

Rabbit Enrichment: Summary of Current Options

Evolution of an Enrichment Device

The Science Behind Enrichment—A Look at the Literature



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THE Enrichment RECORD

Please direct all inquiries to
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WE'D LOVE TO HEAR FROM YOU!
We welcome your comments, observations and contributions to *The Enrichment Record.* Contributors include lab animal veterinarians, principal investigators, animal care staff, animal behaviorists, animal technologists and members of the bioscience community who promote the 4 Rs: reduction, replacement, refinement and respect.

Share your story ideas with Rhoda Weiner, Editor at
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Guidelines for authors can be accessed at
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Please give credit where credit is due.
Outstanding animal care is truly a team effort, and we ask you to credit colleagues, published reports, articles, and other reference materials that have contributed to your enrichment article. Great ideas don't happen in a vacuum, and we encourage you to list all sources of inspiration.

The Enrichment Record ***is not a peer-reviewed journal. However, the Editorial Board of this E-Zine is composed of dedicated volunteers who have extensive experience and expertise in the care of laboratory animals. Members of the Board are involved with all aspects of this publication.***

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In Other Words

A QUARTERLY E-ZINE/FORUM FOR:

Discussing environmental enrichment in the optimal care of laboratory animals

Documenting best practices and approaches for addressing challenges of implementation & assessment at every level

Sharing data on the impact of environmental enrichment on the science

Building the case for integrating enrichment into research design

It seems that enrichment is a hot topic. There are so many programs, courses, workshops and articles that we are challenged to keep up.

We can't think of a better venue to stimulate high-level, informed discussion of enrichment than PRIM&R's 2012 IACUC Conference. Recently held in Boston, this major gathering of the lab animal research community offered an "Animal Well-being and the 3Rs" track. Among many engaging topics was a session that focused on "The IACUC's Role in Reviewing and Promoting Enrichment Strategies." It was no surprise to find that Jennifer Camacho and Christina Winnicker were leading the workshop. They are both well known for their enthusiasm and expertise. Their IACUC focus takes enrichment seriously and raises institutional oversight to a new level.

That same week, the Massachusetts Society for Medical Research (MSMR) had a full house for their annual Laboratory Animal Enrichment Symposium. The workshops covered the gamut of lab species, including zebrafish, mice, rats, free-range rabbits, pigs and dogs. In keeping with the need to promote change in the institutional culture, there was an intriguing session entitled "Fitting Square Pegs into Round Holes: Tactics for Seemingly 'Unenrichable' NHP Biomedical Environments." Also on the agenda was Natalie Bratcher, 3Rs Scientist and Alternatives Coordinator at Abbott Laboratories, who was this year's recipient of NJABR's "Common Pathways" Award. She was recognized for her commitment to seeking alternative methods to advance science and improve animal welfare.

Coming up is the **Enrichment Extravaganza** at Emory in Atlanta on April 24 and a special Enrichment Section for posters at the Tri-Branch Symposium in Atlantic City in June.

To keep our readers up-to-date, we really need reporters, who can share information and ideas being generated across the country at meetings like those mentioned above. If you are interested in joining our dedicated team of volunteers, just say the word.

Contact me at *mackta@enrichmentrecord.com*

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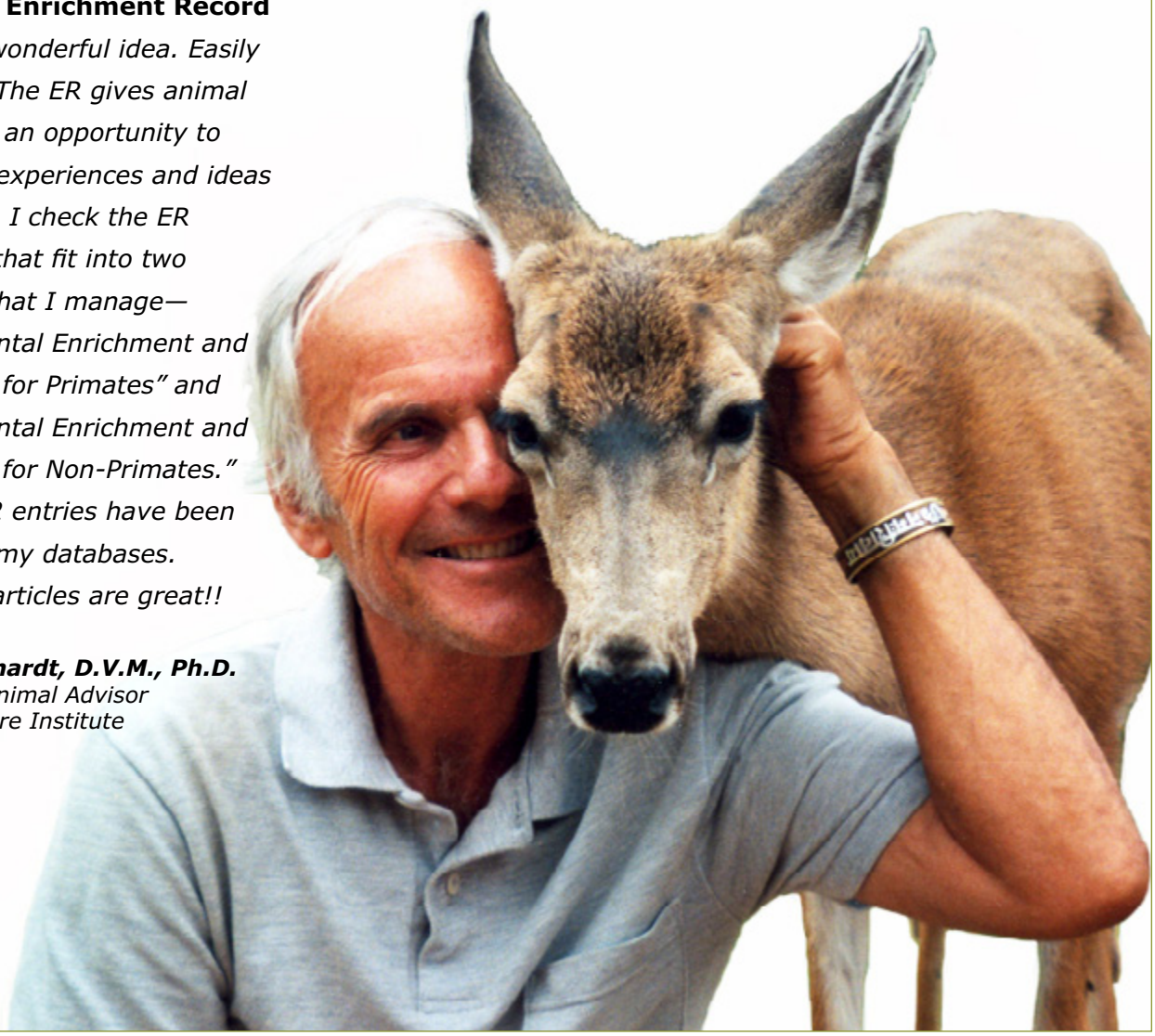
Looking Forward |

We are thrilled to announce that Penny Hawkins, BSc, PhD, will serve as *The Enrichment Record*'s first guest editor. Dr. Hawkins is Deputy Head of the Research Animals Department in the Science Group of the RSPCA. She works to promote refinements to improve animal housing and care—especially rodents and birds—and to assess the welfare of laboratory animals. Other key areas include refining procedures to reduce suffering, animal use in fundamental (basic biology) research, and the ethics of animal experimentation. She is a member of the Animal Procedures Committee (APC), the body that advises the secretary of state on the implementation of the UK Animals (Scientific Procedures) Act 1986. Penny has also been involved in the revision of the European guidelines for laboratory animal husbandry, and the development of the new regulations on animal use for EU Directive 8869/10.

OUR READERS TELL US....

Having **The Enrichment Record** *online is a wonderful idea. Easily accessible, The ER gives animal care people an opportunity to share their experiences and ideas with others. I check the ER for articles that fit into two databases that I manage—"Environmental Enrichment and Refinement for Primates" and "Environmental Enrichment and Refinement for Non-Primates." Thus far, 22 entries have been included in my databases. I think the articles are great!!*

Viktor Reinhardt, D.V.M., Ph.D.
Laboratory Animal Advisor
Animal Welfare Institute



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noun

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Common Pathways Award

The New Jersey Association for Biomedical Research (NJABR) presented the 2012 "Common Pathways" Award to Natalie Bratcher, 3Rs Scientist and Alternatives Coordinator at Abbott Laboratories at the 3Rs Sharing Conference on March 2. The Common Pathways Award was established to recognize individuals who are re-thinking and re-shaping traditional bioscience methods to open new pathways leading to better health.

Call for Proposals!

Attention veterinarians, lab technicians, animal technicians, and all who work with laboratory animals: The Johns Hopkins Center for Alternatives to Animal Testing (CAAT) is now accepting proposals for the 2012 Science-based Refinement Awards (formerly the Animal Welfare Enhancement Awards).

The focus of these awards is to elicit scientific evidence to support the enhancement of the housing, handling, and/or experimental situations for laboratory animals.

These awards are intended for veterinarians and laboratory and animal technicians. They are limited to North American applicants only.

Each award will be for $6,000.

The deadline for proposals is September 28, 2012.

For information and proposal guidelines, please see: http://caat.jhsph.edu/programs/awards/AWE/2012/index.html

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Program Organizers: The Enrichment Record & Yerkes National Primate Research Center

MORNING PLENARY

One size does not fit all: Taking individual differences into account in behavioral management practices for non-human primates
Dr. Kristine Coleman, Oregon National Primate Research Ctr, Beaverton, OR

Developing a Framework for an Environmental Enrichment Program for Laboratory Fish
Christian Lawrence, Children's Hospital, Boston, MA

Utilizing Environmental Enrichment as a Tool to Enhance Good Husbandry & Care for Rodents
Dr. Karen Froberg-Fejko, BioServ, Frenchtown, NJ

Poster Award Presentations

LUNCHEON

AFTERNOON BREAKOUT WORKSHOPS

Rabbit Enrichment • Dr. Karen Froberg-Fejko, BioServ

Cognitive Enrichment for Non-human Primates
Dr. Jessica Crast, Yerkes & Dr. Bonnie Perdue, Georgia State University

Enrichment for Mini-Pigs • Michelle Salerno, Marshall BioResources

Enrichment in Toxicology – Past, Present & Future • Genny Andrews-Kelly, HLS

Positive Re-enforcement Training for Swine to Improve Data Collection & Promoting Nature Behaviors in Sheep through Environment Enrichment
Cindy Evans, Baylor College of Medicine

Enrichment for Ferrets • Michelle Salerno, Marshall BioResources

Operant Training for Non-human Primates: How to Train for Research-related Behaviors
Dr. Mollie Bloomsmith. Jaine Perlman & Jennifer McMilian, Yerkes

Early Developmental Canine Socialization & Enrichment • Dr. Kimberley Cohen, Covance

Mouse Neurobehavioral Testing and Enrichment: Does Enrichment Affect Testing?
Cathryn Coke-Murphy, Vanderbilt University

To register or to submit an abstract contact:
Denise Bianco at 908.228.2203 or bianco@enrichmentrecord.com

A Novel Delivery Device for Rabbit Hay

PROBLEM

To find an efficient way to deliver hay to rabbits that eliminates waste and prevents contamination.

Problem-Solvers

Leslie Sheppard Bird, CVT,RLATg
Elizabeth Dodemaide, BVSc, MACVSc
David C. Reimer, DVM

Kudos to the creative team in Laboratory Animal Services at Rutgers, The State University of New Jersey, for finding an efficient way to deliver hay to rabbits that eliminates waste and prevents contamination.

Liz Dodemaide describes the way it happened:
"We feed rabbits hay, partly as a source of roughage and also for enrichment. We were wasting a lot because the rabbits would push it around to get at their food pellets. Hay would fall through the floor grids or would get contaminated by urine and feces. We needed an inexpensive, sanitary, sturdy container that would provide the rabbits easy access to the hay."

It was Dave Reimer, who suggested trying a balloon whisk, hinting at kitchen experience unknown to his colleagues in the lab. Liz, a cook with international credentials, searched online cooking sites for stainless steel whisks with the desired flexibility. She had immediately ruled out whisks made of plastic or silicone, explaining, "They are soft and lovely but are easily destroyed by the rabbits." Her search resulted in pricey products well beyond the reach of an academic research program.

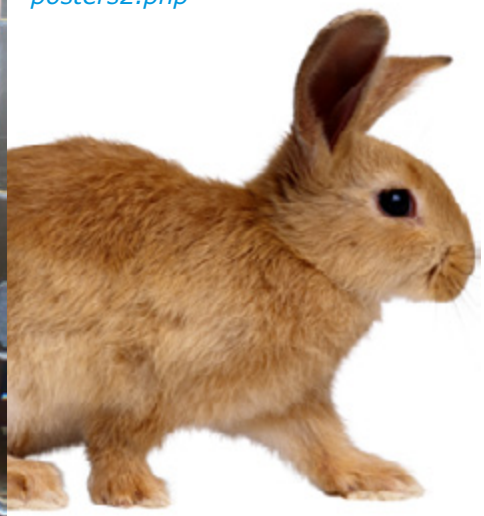
Leslie Sheppard Bird

Whisk filled with fresh hay

Never one to waste time, Liz found the perfect lab whisk while doing a family shop over the weekend. She purchased a $7 whisk, which she handed over to Leslie Sheppard Bird for testing. After careful study, Leslie figured out the best method for securing the experimental hay container to the cage and collected enough data to satisfy any concerns about the whisk or its new function.

The only unintended consequence has been Leslie's increased demand as a presenter. She is on the road and in demand, having accompanied the team's award-winning poster to regional and national meetings. She has also been a featured speaker at an AALAS branch meeting where she described the creative process of developing the device as well as the poster.

The poster can be found in *The Enrichment Record* Poster Repository; *http://www.vetbiotech.com/posters2.php*



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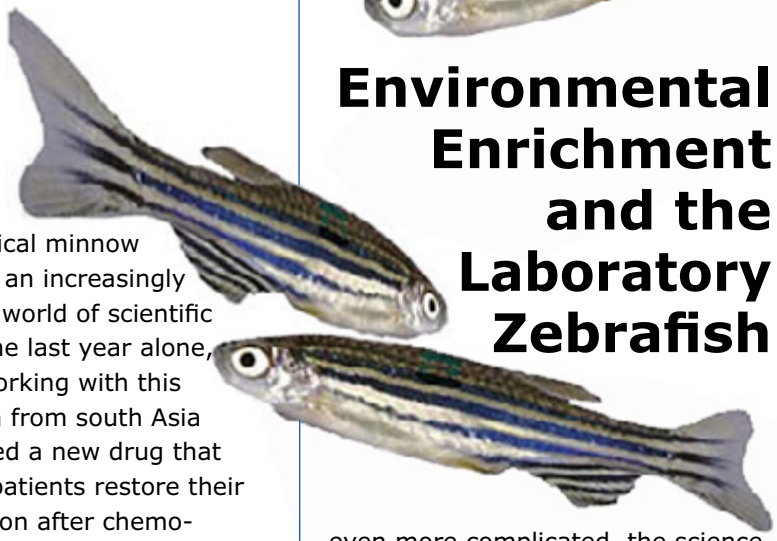
Christian Lawrence, M.S., Fish Biologist, Aquatic Resources Program Manager, Children's Hospital Boston

Environmental Enrichment and the Laboratory Zebrafish



Introduction

The zebrafish *(Danio rerio)* is a small tropical minnow that is playing an increasingly big role in the world of scientific research. In the last year alone, researchers working with this diminutive fish from south Asia have discovered a new drug that helps human patients restore their immune function after chemotherapy or bone marrow transplant (Goessling et al., 2011), and identified potential new therapies for both melanoma (White et al., 2011) and Duchenne muscular dystrophy (Kawahara et al., 2011). It is because of advances like these that it is, today, quite common for a typical animal research facility to house hundreds, if not thousands of zebrafish, alongside more traditional laboratory animals like mice and rats.

This new landscape where zebrafish and other aquatic animals are now playing a prominent role in the laboratory animal field is exciting, dynamic–and extremely challenging for institutional animal care and use programs. Caring for and managing fish populations in a controlled environment is an entirely different proposition than it is for traditional mammalian species; it requires a knowledge base and skill set that many laboratory animal professionals do not possess. To make matters even more complicated, the science of husbandry and management for the zebrafish is surprisingly poorly developed (Lawrence, 2007). In truth, relatively little is known about the biology and behavior of the animal as it relates to their maintenance and care in the laboratory settings. Indeed, most of the "standard methods" (or what passes for them) for care frequently cited in the literature (e.g. (Westerfield, 2007) are only, at best, loosely based on the scant scientific information of this nature that is available, and have never been thoroughly vetted by systematic research. There is a growing movement afoot to address these shortcomings (Lawrence, 2011), but the field is still woefully behind where it needs to be on this front.

Given these realities, it should come as no real surprise to anyone that the concept of welfare improvement, most notably the practice of environmental enrichment that has become so important for helping to improve the welfare of agricultural, zoo, and mammalian laboratory animals, is not well defined for the zebrafish. Very few institutions have such a program in place for their fish, but many are now seriously considering it.

There are two primary reasons for this. The first is somewhat sentimental in nature: when the average person walks into a typical zebrafish facility, they encounter hundreds or even thousands of groups of fish housed in bare plastic or glass tanks. A natural human reaction to this is to wonder if these are conditions most conducive to the welfare of the fish. After all, these animals evolved in habitats that have great structural complexity by comparison. In light of this fact, is it "fair" to house them in such "barren" environments?

The second reason is more practical: regulatory agencies that oversee the care and use of laboratory animals now require it. For example, the most recent edition of *The Guide for the Care and Use of Laboratory Animals*, the internationally accepted primary reference on animal care and use required in the United States of America by the Public Health Service Policy, contains

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specific new sections on both environmental enrichment and the care and management of aquatic animals. This development, perhaps more than any other, is now compelling institutions to seriously explore how they may improve the welfare of the fish in their laboratory animal programs.

It is somewhat unrealistic to expect that a full-fledged formal enrichment program for laboratory zebrafish can be developed overnight, given the aforementioned immature state of the zebrafish field. However, it is possible to use what is currently known about zebrafish natural history and behavior, in combination with available tools to assess well-being in fish, to help establish a biologically sound, performance-based approach for improving the welfare of these fish in research settings.

Natural History

In nature, the zebrafish occurs across a broad swath of south Asia: much of India, Bangladesh, and lowland Nepal (Spence, Gerlach, Lawrence, & Smith, 2008). The fish can be found throughout this huge and diverse geographic region in nearly every freshwater habitat imaginable, including ponds, streams, irrigation ditches, margins of lakes, and the backwaters of larger river systems. These waters are typically quite turbid, with low visibility and abundant submerged vegetation. A key feature of these habitats is their temporal variability due to the monsoonal climatic regime that dominates this section of the world; conditions often vary considerably in temperature, chemistry, size and connectivity. In short, like many other animals native to this region, the zebrafish

Female zebrafish in enriched tank

is supremely adapted to deal with fluctuating conditions in the environment.

Ecologically, zebrafish are a shoaling species, associating with conspecifics in small, mixed sex schools of 10-20 individuals in the mid to upper part of the water column (Engeszer, Patterson, Rao, & Parichy, 2007). They have a reproductive strategy typical of animals lower in the food chain: they grow and mature rapidly and produce large numbers of offspring before something else eats them or their habitat disappears. Breeding is thought to take place primarily during the rainy season, when resources are most abundant (Spence, Fatema, Ellis, Ahmed, & Smith, 2007). The fish spawn in shallow water, scattering newly fertilized eggs in weedy areas along the margins of water bodies. There is no parental care, and the embryos hatch and subsequently grow up in protected, vegetated zones rich with zooplankton, their preferred food source.

Normal Behavior

Zebrafish behavior is still largely a mystery to scientists, even to those that have studied and worked with the fish for many years. However, data from a growing number of studies are helping to paint a more complete picture of how this little animal "goes about its business" in life, especially in controlled, closed environments.

Perhaps the most important generalized behavioral trait of the zebrafish is that it is a highly olfactory animal. The fish uses its sense of smell to detect and avoid predators, locate food, discriminate between kin and non-kin, and to select mates. The role of olfaction in reproduction in this species is particularly illustrating. It is thought that female zebrafish choose breeding partners upon the basis of smell, as they have been shown to prefer the odors of non-related males to that of male siblings or close relatives (Gerlach & Lysiak, 2006). During the act of spawning, males release pheromones that promote ovulation in females, who in turn release pheromones that stimulate courtship behavior on the part of the male that eventually culminate in oviposition and fertilization of released eggs (Vandenhurk & Lambert, 1983). Pheromones also play a repressive role; water containing the odor of dominant females has been shown to decrease egg production in subordinate females (Gerlach, 2006). These examples should serve to remind human caretakers of the fish that an aquatic environment that may appear barren or empty may

actually be rich in chemical signals critical to animals whose behaviors are governed in large part by their sense of smell.

While aquarium hobbyists often characterize zebrafish as being a peaceful schooling species, they are actually quite territorial. In captive situations, the fish readily establish dominance hierarchies, and aggressive interactions within and between sexes are common (Spence et al., 2008). Aggression, which most frequently takes the form of chasing or biting, is often centered on resources such as food or preferred spawning sites. The intensity of agonistic behavior is generally inversely correlated with density; aggression tends to be highest in situations where only a few animals occupy a given space because territories are easiest to defend under such conditions. As the number of animals increases within a given space, the frequency of aggressive interactions tends to decrease because territories become increasingly difficult—and eventually impossible—to defend (Harper & Lawrence, 2010). It is important to note that the fish will become crowded above certain threshold densities, and that this situation is known to be stressful (Ramsay et al., 2006).

Another important behavioral characteristic of the zebrafish is their relationship to structure, specifically plants. In the wild, the zebrafish is known to inhabit environments with abundant submerged vegetation (Engeszer et al., 2007; Spence et al., 2006). Unsurprisingly, plants are thought to play an important role in a number of species—typical behaviors, including oviposition (Spence, Ashton, & Smith, 2007), larval emergence and gas bladder inflation (Laale, 1977), and avoidance of predators or aggressive conspecifics (Hamilton & Dill, 2002). Importantly, these behaviors appear to be conserved in domesticated fish. If given a choice, captive fish show a strong preference for structure (Kistler, Hegglin, Wurbel, & Konig, 2011). In a pattern similar to that demonstrated in other animals, zebrafish show enhanced learning capabilities when reared in structurally complex environments (Spence, Magurran, & Smith, 2011).

Assessing Well-Being in Zebrafish

Devising and eventually implementing a strategy for improving zebrafish welfare is only possible if there is a way to measure how well it is working. To that end, there are three basic indicators that are most often used to help assess well-being in fishes: behavior, performance, and physiology.

Observing behavior is often the simplest and most direct way to determine how an animal is faring in its environment. Understanding what constitutes "normal" behavior is key to this, so that abnormal, or maladaptive behaviors can be quickly identified and the underlying causes resolved. Normal behaviors of zebrafish include the occupation of the entire water column in a given space (from just beneath the surface to the bottom), moderate activity levels, loose schooling, and infrequent displays of aggression (chasing, fighting, biting). Maladaptive or negative behavioral indicators include quick or erratic burst swimming, bottom swimming, freezing, gasping for air at the water surface, rapid fanning of the opercula, tight schooling, and frequent or even constant aggression. In many instances, these maladaptive behaviors will be observed in combination with one another. For example, if one or more fish in a group perceive a threat or other negative stimuli, the animals may swim together erratically along the bottom of a tank in a tight knit school. The differences between normal and maladaptive behaviors in zebrafish are quite striking. Once a caretaker is properly trained to recognize these behaviors, it is relatively easy to identify a tank or tanks of fish where something is wrong.

Performance is perhaps the most widely utilized method of measuring the well-being of zebrafish. The most common performance indices used for fishes are growth, survival, and reproductive rates. Examples of neutral or positive performance indices for zebrafish include good growth rates, with fish reaching sexual

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Adult female zebrafish

Typical zebrafish housing system

maturity within 3-4 months, with a uniform size distribution of the animals in an individual clutch of offspring. Once the fish reach sexual maturity, they should be able to reliably produce high quality embryos during natural mating events. Survival rates of the resultant offspring should be in excess of 80% during the first 30 days post-fertilization. After that point, mortality should be very low until the fish become senescent. When fish take longer than 4 months to mature, and/or show a high variation in the size of individuals within a cohort, it could signify that welfare may be compromised. Poor survival and reproductive rates are also negative performance indicators. It is important to remember, however, that "good" performance does not always necessarily positively correlate with welfare.

A more sophisticated means to assess welfare in fish is to monitor changes in physiology. Various physiological indicators can be used to provide a measure of the stress, reproductive, and health status of individual or groups of fish. Stress is generally assessed upon the basis of circulating levels of plasma cortisol, and/or the expression levels of genes related to the stress response. Physiological indicators of reproductive function include measures of plasma concentration of sex steroids, and/or the expression of genes involved in sex steroid production in the gonads or in yolk production in the liver. A measure of health status may be gained by examining the expression of genes involved in immune function, the most notable of which are the cytokines. These markers are often measured after the fish have been subjected to a defined environmental challenge. In the case of all three physiological indicator types, it is critical to define baseline values for the selected markers. In general, elevated production of stress hormones and decreases in sex steroid production and immune response elements are considered to be negative indicators, while lower levels of stress hormones and basal or increased levels of steroid production and immune response metrics are considered neutral or positive. Importantly, the context of each particular analysis has to be taken into account when interpreting these kinds of results.

The most comprehensive way to measure the well-being of zebrafish is to combine all three approaches in a single analysis. For example, in a recent study, Filby and co-authors characterized the consequences of social status in zebrafish (Filby, Paull, Bartlett, Van Look, & Tyler, 2010). The social status of individual animals in groups of zebrafish was defined upon the basis of stereotypical behaviors, and then correlated with performance (growth, reproductive output) and physiological indicators (cortisol, sex steroid production and immune function). This work is instructive and important because it provides a biological baseline for defining the welfare of zebrafish maintained under conditions typical of most

laboratory settings. Studies such as these provide precisely the kind of scientifically justified information that is required by managers to devise sound welfare management practices for this species.

Strategies for Improving the Welfare of Zebrafish in Laboratory Settings

Based upon the information and associated references presented in this article, it is possible to implement a number of relatively simple approaches that can be expected to have a positive effect on the welfare of zebrafish in laboratory settings. Establishment of even the most basic of measures is a good place to start, especially if the practices are carefully grounded in data on the natural history and normal behavior of the animal and supported by one or more indicators of welfare. A list of suggested practices might include:

- The provision of training on both normal and maladaptive zebrafish behaviors to caregivers and research staff working with the fish so that they may regularly observe and monitor the animals for signs of stress.
- The establishment of performance based policies on housing densities that are 1) specific to different life stages and research applications, and 2) set thresholds for *both* the minimum and maximum number of animals allowed in a given space or enclosure.
- The inclusion of live zooplankton, including *Artemia* (brine shrimp) nauplii and rotifers, in the diet of the fish, especially during the larval stage.
- The addition of non-toxic, sanitizable plastic plants in breeding and in low-density housing situations (especially pairs).

Conclusion

Zebrafish are an important laboratory animal model species, and strategies for their management in research settings should always incorporate considerations of their welfare. Although there is still much to learn about the biology, natural history and normal behavior of this species, institutional animal care and use programs should ensure that their zebrafish-related policies and practices reflect the most current scientific understanding of the animal and how it interacts with and relates to its external environment.

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Beyond Environmental Enrichment

We will be "beyond" environmental enrichment when what we now call enrichment is just plain providing good environments. Already, we are seeing research papers where large group housing of rodents with bedding is considered the standard environment[1], but in other institutions barren housing is a staunchly defended norm. And I would argue what is missing in these cases is not justification for enrichment, or the enthusiasm for proving it—but a proper integration of animal welfare with scientific and economic drivers of behavior when it comes to actually creating the environments in which we house animals.

Enrichment is an aspiration message, which must engage with economic and professional realities without surrendering to them. But to simply acknowledge that we need money to make enrichment happen, need to enhance the overall function of the animal in its role—such as a scientific model– is not a distraction; it is a core part of the job of making enrichment mundane, making it just something everyone does. It is a core feature of psychology that if someone is doing a behavior you don't want, like refusing to allow a form of enrichment, pushing back just places that person at the uncomfortable meeting of two motivations. To change their behavior, you have to identify and manipulate the source of the motivation.

For example, there is a resistance to change, to maintain standardization. It is easy to simply argue against this objection. Standardized housing, we know, must efficiently capture the key features of the typical environment, sufficient to allow the animal to function normally; it must be fully reported in experimental studies and an explicit part of the research model. By contrast, we see quite a lot of housing which seems to have affordability and sanitation as a primary rather than a secondary goal. Report of caging is often incomplete and sometimes entirely absent. Environments tend to be barren, especially for small animals that are on experiment. And, while these environments are known to cause deficits in physical and psychological systems, in many places they are tolerated.

This is not a problem with standardizing; it is a problem in how standardization is pursued (and the impression being given that it is currently being achieved). Studying subtle effects is difficult without long term, explicit and standardized conditions. And changes in these conditions need to be harmonized; they take extra time and money, and they can affect research results. Denying these realities simply undermines the standing of the enrichment advocate, just as denying the need for enrichment undermines the standing of the researcher. Because it is getting very hard for anyone to deny that housing animals in barren conditions is no longer acceptable morally or scientifically, enrichment is going to be the New Standard.

Reaching this standard will be an inconvenience for some animal users, which should be acknowledged and mitigated, but not—in itself—

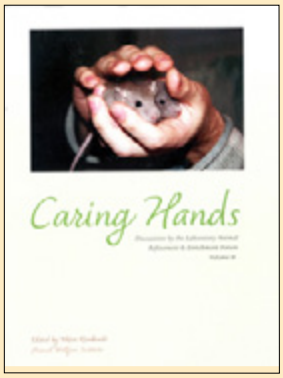
allowed to be an obstacle to progress. In order to get to a post-enrichment age, we need to separate the objections to enrichment that are rationalization. We need to take on the real objections as part of the enrichment cause. And we need to show that bold steps towards ideal housing will overall produce better results and be less inconvenient—because a housing system that is based on mandated barren minimum will be subject to constant incremental change as guidelines and regulations change. We need to push for the establishment of authoritative "reach" standards for enrichment that make this goal easier, not a constantly creeping minimum.

In order for those whose focus is budgets, branding and research to truly embrace enrichment—we will need to truly embrace their goals too. We need to really understand how the data might be affected and not assume it will always be positive. We need to develop cost effective options that can be sourced locally, We need to be able to see first how enrichment affects the animal, but not stop there--and also see how it affects the science and the bottom line. And, when this is done, we may finally find that enrichment, which is basically a word for 'good husbandry that not everyone does', will finally become completely obsolete.

[1]Wood NI, Carta V, Milde S, Skillings EA, McAllister CJ, et al. 2010 Responses to Environmental Enrichment Differ with Sex and Genotype in a Transgenic Mouse Model of Huntington's Disease. PLoS ONE 5(2): e9077

Resources

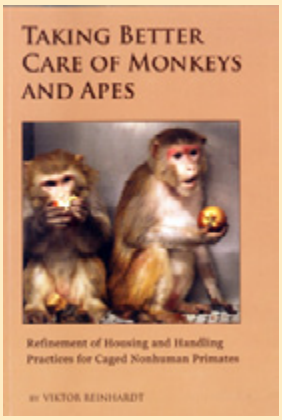
One copy free to individuals at research facilities!



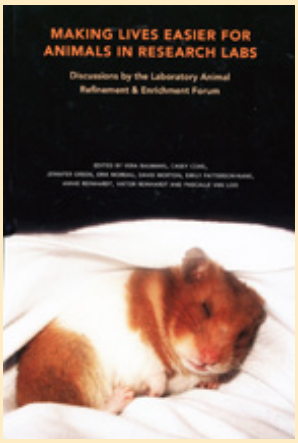
Caring Hands
Discussions by the Laboratory Animal Refinement and Enrichment Forum, Volume 2
Edited By Viktor Reinhardt
Animal Welfare Institute,
Washington, D.C. (2010)

Roots of Human Behavior
Viktor Reinhardt
Animal Welfare Institute,
Washington, D.C. (2009)

Variables, Refinement and Environmental Enrichment for Rodents and Rabbits Kept in Research Institutions
Viktor and Annie Reinhardt
Animal Welfare Institute,
Washington, D.C. (2006)



Taking Better Care of Monkeys and Apes
Refinement of Housing and Handling Practices for Caged Nonhuman Primates
Viktor Reinhardt
Animal Welfare Institute,
Washington, D.C.
(2008)



Making Lives Easier For Animals In Research Labs
Discussions by the Laboratory Animal Refinement and Enrichment Forum
Edited By Vera Baumans, Casey Coke, Jennifer Green, Erik Moreau, David Morton, Emily Patterson-Kane, Annie Reinhardt, Viktor Reinhardt and Pascalle Van Loo
Animal Welfare Institute,
Washington, D.C.(2007)

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AWI is a nonprofit educational organization. Since its founding in 1951, AWI has promoted humane treatment of laboratory animals, emphasizing the importance of socialization, exercise, and environmental enhancement. Educational material published by AWI is available free to scientific institutions and libraries and at cost to others.

Enrichment Track at the 2012 Virtual Laboratory Animal Science BioConference Live

3,958 attendees • 6,810 registrants • 504 average booth visitors • 189 average track viewers • 381 average keynote viewers

The Veterinary Bioscience Institute and BioConference Live, a product of LabRoots, brought together laboratory animal science professionals and experts for a groundbreaking virtual conference, the Laboratory Animal Science (LAS) BioConference Live, which took place on February 15th and 16th of this year. The theme of the 2012 conference, **Animal Well-Being and Welfare Science**, included three tracks: Enrichment, Housing and Anesthesia/Analgesia. The Enrichment track was the first to be suggested and adopted because enrichment plays a significant role within the laboratory animal science field.

Enrichment has received more attention with the publication of the new edition of the **Guide for the Care and Use of Laboratory Animals** as well as updated guidelines within the new European Directive. Furthermore, as science addressing enrichment is continually being collected, this conference allowed for global sharing of up-to-date information. The Enrichment track featured world-renowned experts in the field of enrichment as well as future leaders such as Laura Graves, who addressed the effect of auditory enrichment on abnormal, affiliative, and aggressive behavior in laboratory-housed rhesus macaques. The Veterinary Bioscience Institute supports new and rising stars in research by giving them a venue to present their research findings. These individuals are imperative to the ever-evolving field of laboratory animal medicine, as the energy, focus, drive and ideas that they bring to the field are astonishing.

The LAS BioConference Live featured live video keynote presentations where attendees had an opportunity to have their questions answered by presenters in real time. Conveniently held online for free, the Virtual Bioconference was easily accessible, time-efficient and cost-effective.

The Laboratory Animal Science BioConference Live featured the following speakers and topics in the Enrichment Track:

Mollie Bloomsmith, Ph.D.
Director of Behavioral Management, Yerkes National Primate Research Center

Positive Reinforcement Training for Laboratory Primates
Primates living in laboratories, primate research centers and pharmaceutical companies are trained for certain animal care, research and veterinary procedures. Traditionally, a variety of training approaches were used. More recently, people working with these primates have begun relying solely on positive reinforcement training to accomplish these objectives. Positive reinforcement training programs have become more prevalent in laboratory primate facilities, and they are gaining importance in the daily management of nonhuman primates.This approach to training involves rewarding the animal for performing a behavior that the trainer wants, with no use of force or coercion to achieve the desired behavior. Over the last 20 years, many primates have been successfully trained to execute behaviors helpful in their daily husbandry procedures, in facilitating research on the animals, and in attending to their health. This presentation gave examples of

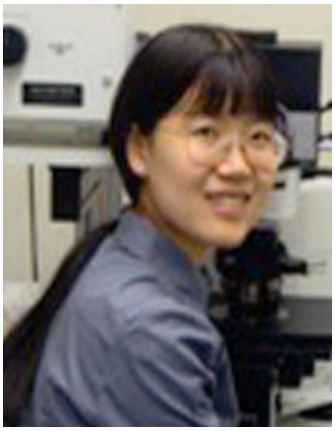
monkeys and apes trained to move between areas of their enclosures on cue, for body examination behaviors, to cooperate with receiving injections, and for the collection of their urine and blood samples. This type of training improves the care and welfare of these animals by gaining their voluntary cooperation in behaviors that are a part of the life of laboratory primates.

Hannah Buchanan-Smith, B.Sc., Ph.D.
Professor of Psychology, University of Stirling, Scotland

Understanding Common Marmosets, Callithrix jacchus, to Improve their Welfare in Captivity

The common marmoset, Callithrix jacchus, is the most frequently used New World primate in laboratory research and testing, due to its small size, apparent breeding success, and easy handling, which makes them comparatively inexpensive to keep. However, there are considerable welfare problems associated with their use in laboratories, which include marmoset wasting syndrome, large litters with negative consequences for both dam and infant survival and also potentially for the scientific output given the variation in rearing which may include early deprivation. This presentation summarised the natural history of marmosets to inform welfare decisions for housing and husbandry in the laboratory. Data on the natural adaptations and flexibility of the social organization and dynamics of the species and, consequently, how individuals respond to social and ecological pressures/factors are an important tool to support the management of the species to promote good welfare, which is critical for ethical reasons, financial reasons and also for good science. The website, developed by Dr. Claire Watson and myself, *www.marmosetcare.com* was introduced to illustrate the presentation.

Lei Cao, Ph.D.
Director, Inpatient Cardiology, Assistant Professor of Medicine, Cardiology, The Ohio State University



Environmental Enrichment: Eustress Model for Cancer and Obesity Research in Rodents

A focus of much cancer research is at the molecular and cellular level. In contrast, the effect of lifestyle, social interactions and psychological state is less investigated. Our recent work demonstrates that living in an enriched environment with complex physical, cognitive, and social stimulation leads to improved cognitive and metabolic health, and reduced tumor growth and increased remission. Furthermore, the enriched environment decreases adiposity; increases energy expenditure; causes resistance to high fat diet induced obesity; and induces a genetic, morphological, and functional transformation from white fat to brown fat and subsequent energy dissipation. These robust effects on peripheral cancer and adipose tissues are mediated by the activation of a specific neuroendocrine brain-adipocyte axis: the hypothalamic-sympathoneural-adipocyte (HSA) axis. The enriched environment triggers brain-derived neurotrophic factor (BDNF) gene expression in the hypothalamus of the brain increasing sympathetic tone to fat tissues. The selective sympathoneural modulation of white fat induces brown fat genetic program and subsequent increased thermogenesis and lean phenotype. This brain-adipocyte axis also suppresses leptin production in fat via beta-adrenergic signaling leading to a reduction in cancer proliferation. Environmental enrichment causes a mild benign stress which is beneficial to health, e.g. anticancer and anti-obesity; it therefore can serve as a model for eustress (positive stress) research in rodents.

John Capitanio, Ph.D.
Research Psychologist/Staff Scientist, University of California, Davis, Department of Psychology/ California National Primate Research Center

Understanding Individual Differences in Biobehavioral Organization in Rhesus Macaques: Better Science and Better Management

In fields as diverse as medicine and ecology, there is a growing interest in understanding the causes and the consequences of individual variation in psychological processes referred to variously as temperament, emotionality, behavioral and physiological reactivity, and personality—a constellation of traits that we refer to as biobehavioral organization. Variation in biobehavioral organization

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comes from many sources: genetics, prenatal experience, postnatal experience, and particularly, in the interaction of these sources. And because behavioral and physiological processes are intertwined, such variation has implications for health, and in the context of laboratory animal care, captive management. We have been studying variation in biobehavioral organization in a variety of contexts for nearly 20 years, and in this talk, I reviewed research focusing on a variety of causes of such variation. I also discussed consequences of this variation to demonstrate the value of taking an individual differences approach to issues relating to health, captive management, and science in general.

Andrea Gay, B.A.
Regional Sales Manager and International Sales Representative, The Andersons Lab Bedding Products.

Nesting & Thermoregulation
The Guide says that at lower temperatures, building nests and huddling for resting and sleeping aids mice in thermoregulation. Mice prefer a warmer ambient temperature during the light phase, the period in which mice tend to sleep the most. Laboratory rooms are temperature controlled for human comfort, which is cooler than what mice prefer. Studies have shown that providing nest building materials and promoting nesting behaviors in rodents reduces stress, and in some strains, cannibalization. Being given relevant nesting materials that stimulate their nesting behaviors of gathering, burrowing, sorting and fluffing, decreases some abnormal behaviors. We are all aware that mice in the labs are in an unnatural environment—one in which they have no control of temperature, enrichment products, roommates, and other factors. Nesting material not only helps them regulate their body temperature, but it allows them some control over their environment. It has been suggested that letting mice regulate their own temperatures by building nests might be more effective than trying to alter room temperatures in the lab.

The bottom line may actually be that animals from enriched environments may be more physiologically and psychologically stable, as well as better representatives of the specie—thus ensuring better data collection and scientific results.

Laura Graves, M.A.
Doctoral Student, Southern Illinois University, Department of Anthropology

The Effect of Auditory Enrichment on Abnormal, Affiliative, and Aggressive Behavior in Laboratory-housed Rhesus Macaques (*Macaca mulatta*)
Research has shown that environmental enrichment can reduce abnormal behaviors in captive primates. However, auditory enrichment has generated mixed results. The purpose of this study was to determine if two types of auditory enrichment, white noise and designer music, were effective at reducing aggression and abnormal behavior, while also increasing affiliative behaviors in laboratory-housed rhesus macaques (Macaca mulatta). Forty laboratory-housed rhesus macaques at the Oregon National Primate Research Center were observed for 19 days over a 4-week period. During the first week, subjects were observed with no music to acquire a baseline level of behaviors (Phase 1). During week 2, subjects were exposed to white noise for three hours a day for five days (WN Phase). During week 3, designer music was played for three hours a day for five days (DS Phase). Observations continued into week four to determine if changes in behavior were residual (Phase 4). Results show that white noise was able to significantly increase affiliative behaviors, such as rates of social play and grooming. However, the white noise had minimal effect on reducing aggression or reducing the expression of abnormal behaviors. Designer music was found to decrease aggression, but this was not correlated with the TEST period when the music was played. The designer music was found to significantly reduce abnormal behaviors and also significantly increase rates of social play and time spent in active exploration. Importantly, these behavioral changes were significant during the TEST period when the designer music was being played to the animals.

The designer music was also effective at significantly reducing abnormal behaviors in those animals with adverse early rearing conditions (e.g., nursery-rearing). This study finds that auditory enrichment, specifically designer music, is an effective enrichment strategy to reduce abnormal behaviors and increase affiliative behaviors in laboratory-housed rhesus macaques.

Hansjoachim Hackbarth, Dr. med. vet.
Professor, Director of the Institute for Animal Welfare and Behaviour, University of Veterinary Medicine Hannover, Germany

Environmental Improvement —because not every enrichment makes sense!
Environmental enrichment in laboratory animal science is a very popular way for trying to improve animals' well-being. Many researchers tried to prove that animals, including farm animals, zoo animals and laboratory animals...could keep more natural behaviour when they live in an enriched environment.

For laboratory animals, the results of some articles show that an enriched environment will not influence the result of experiments. Also, the conclusions of some articles show that some animals are more aggressive or the variation of data seems to be higher in an enriched environment. Thus, more consideration should be given to the potential impact of the type of accommodation, and that of the environmental and social enrichment programmes, on the outcome of scientific studies, in order to avoid the generation of invalid scientific data and consequential animal wastage.

Therefore, the actual problem is that we need to prove that an enriched environment is really for the benefit of the animals and will not disturb the results or increase the necessary numbers of animals. Such kind of enrichment then should be regarded as necessary, should be called "Environmental Improvement" and needs to be introduced as standard housing conditions. As many of today's common housing conditions are empirically developed, more scientific research is necessary in the field of Laboratory Animal Science, as only more knowledge about the basic needs of laboratory animals will improve their animal welfare.

Kathy Laber, D.V.M., M.S., DACLAM
Professor, Department of Comparative Medicine, Medical University of South Carolina
Director, Animal Resources, Ralph H. Johnson VA Medical Center

The Impact of Nesting Material on Measures of Behavior Relevant to Ethanol Intake in Isolated or Group Housed C57Bl/6J Mice

The goal for housing rodents used in biomedical research is to enhance their well-being without confounding the intended objectives of animal use. Providing nesting material has been documented as a way to enhance well-being through providing environmental enrichment; however, there is debate as to whether or not its use may confound research objectives.This study was designed to provide additional clarification on this concern through evaluating the impact of nesting material in a previously established stress model of isolation during early development that induces high alcohol (ethanol) self-administration. The study was conducted with adolescent male and female C57BL/6J mice housed in isolation or in groups that were either being provided enrichment or not. The impact of these housing conditions was assessed during adulthood by measuring voluntary ethanol intake, anxiety, and plasma corticosterone levels. Results of this study indicated that females drank more than males [$F(1,179)=80.3$; $p<0.001$]. Chronic social isolation during adolescence induced higher voluntary ethanol intake than did group housed animals without enrichment [$F(1,179)=7.1$; $p<0.01$]. However, interestingly, mice housed in isolation but in an enriched environment did not show elevated alcohol intake (compared to the group-housed non-enriched group). Overall, corticosterone levels were higher after three weeks of alcohol intake. Basal corticosterone was not affected by housing, enrichment conditions, or sex. Moreover, corticosterone levels did not relate to levels of voluntary ethanol intake. Although this effect did not reach statistical significance, singly-housed mice showed lower levels of anxiety than group-housed mice before testing of alcohol intake started. Overall, these results indicate that housing conditions and their interactions during a critical developmental period can significantly modulate voluntary alcohol intake later in life. In addition, these results signal that enrichment can impact on the research variable of interest, and should be accounted for in the experimental design.

Christian Lawrence, M.S.
Fish Biologist, Manager of Fish Facilities, Children's Hospital, Boston

Environmental Enrichment and the Laboratory Zebrafish
Over the past several decades, the zebra fish (Danio rerio) has become an important laboratory animal model, on par with "traditional" mammalian animals such as mice and rats. The rise of the fish to its prominent position in the

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arena of biomedical research has, among other things, prompted specific treatment of fish and other aquatic animals in the most updated versions of regulatory documents used by governmental agencies to help ensure humane and responsible use of animals in experiments, including the 2011 edition of *The Guide to the Care and Use of Laboratory Animals*. One of the most important expectations that arises from this inclusion is that methods for husbandry, management, and care of the fish are grounded in the best available scientific understanding of the animal. The goal of this presentation was to outline what is known about the biology, behavior, and natural history of the zebrafish in the context of how this information may be used to improve its welfare in laboratory settings.

Anna Olsson, Ph.D.
Researcher, Group Leader, Institute for Molecular and Cell Biology, University of Porto, Portugal

Enrichment or Artgerechtheit: thinking critically about how to house laboratory animals

The way captive animals are housed strongly influences their welfare. This is not difficult to realize when considering that they often spend all their time in their primary enclosure, whether a cage or a pen. Concerns over the negative aspects of restrictive housing were first raised in farm animal production, where the 1964 publication of the book *Animal Machines* set in motion a process which led to political changes as well as development of research to inform animal welfare policy. Methods to evaluate housing systems from an animal welfare perspective have largely been developed within a farm animal setting, but are equally applicable to laboratory animals. Measures of behaviour, in particular in terms of preference and motivation to access resources, play a central role. In this presentation, I discussed methodology and existing evidence regarding appropriate housing for laboratory rodents. I argued that the term "Artgerecht(e)" (German for "species appropriate") is a more adequate description for the environment we ought to strive for than "enriched". I also discussed other housing modifications which need to be considered when planning housing which takes both animals and research into account.

Emily Patterson-Kane, Ph.D.
Animal Welfare Scientist, American Veterinary Medical Association, Animal Welfare Division

Beyond Environmental Enrichment—Providing Good Environments for Experimental Animals

It may be impossible to truly understand what it means to be an animal, and meeting all of their needs would be extremely difficult. However, the history of research shows that it is not that difficult to keep most kinds of research animals alive and reasonably vigorous by providing only for their basic physical needs. Until recently, environmental enrichment has aimed to compensate for the deficits of a barren environment in creating an animal that is not only alive, but "normal" in all of its basic systems. In the future, these requirements will only become more demanding as we normalize every parameter of the animal from immune function to psychological mood. In addressing more subtle and complex conditions, it is becoming clear that the animals and the exact nature of their interaction with their lifelong environment are an integral part of the research model. Also, the clinical and field situations for humans and animals are increasing bi-translational: the animal model can enrich our understanding of how health and well-being are created, supported, maintained, undermined and corrected; and by this same process we become just a little closer to understanding what life is like for the research animal itself and how to make that—wherever possible—a life worth living.

Steven J. Schapiro, Ph.D.
Associate Professor of Comparative Medicine, Chief, Section of Primate Behavior and Environmental Enrichment, MD Anderson Cancer Center, University of Texas, Michale E. Keeling Center for Comparative Medicine and Research

Behavioral Management Strategies That Enhance Welfare in Captive Colonies of Nonhuman Primates

For almost 25 years, the rhesus monkeys and chimpanzees living at the Michale E. Keeling Center for Comparative Medicine and Research have been receiving a substantial amount of environmental

enrichment on a daily basis. Similarly, the owl monkeys and squirrel monkeys that arrived at our facility approximately five years ago also receive numerous environmental enrichment opportunities. Recently, we have been expanding our enrichment efforts to provide our captive primates with a variety of new opportunities specifically designed to both challenge the animals and to create situations in which they can express important species-typical behaviors. In addition, for over 20 years, we have been employing positive reinforcement training techniques so that our chimpanzees (primarily) will voluntarily participate in a number of activities that are essential for their care and management. Many of our primates also participate as subjects in a wide variety of basic behavioral science investigations focusing on questions that include: laterality, prosociality, cultural transmission, and behavioral economics. Several of our behavioral study procedures have proven to be stimulating, challenging, and enriching for the animals. Similarly, most of our training procedures, in addition to facilitating necessary behaviors, provide the animals with numerous chances to exhibit control and choice. In this talk, I described a number of our enrichment, training, and study techniques, and attempted to demonstrate how these practices help refine our management procedures and enhance the welfare of the nonhuman primates living at the Keeling Center.

Suzette Tardif, Ph.D.
Associate Professor, Cellular & Structural Biology, Barshop Institute for Longevity and Aging Studies, University of Texas Health Science Center

Common Marmosets in Biomedical Research: Habituation, Training and Assessment of Distress

Marmosets represent an important but often poorly understood research resource. The relatively small size and low zoonotic risk of these animals makes them appealing as research subjects in a number of areas. However, the historic portrayal of them as difficult to manage and handle has limited their use. Species-specific understanding and protocol development is needed in order to avoid pitfalls that stem from treatment of marmosets as "very small macaques" or "very smart rats". In this presentation, basic guidelines were provided on the management and handling approaches for marmosets. Topics included transport and acclimation, location changes within a facility, diet changes, removal from and return to social groups, capture and restraint, handling for anesthesia, post-procedural monitoring and staff training. Emphasis was placed on methods for habituation, use of positive reinforcement training and the difficulties of distress assessment in these highly active, vigilant primates.

To facilitate informed discussion about environmental enrichment, we have joined the Linkedin Group called Laboratory Animal Sciences.

This group allows members of the laboratory animal science community and our readers to interact over a web-based platform to compare ideas and methods. To participate, you will need to create a Linkedin account and then join the Laboratory Animal Sciences Group.

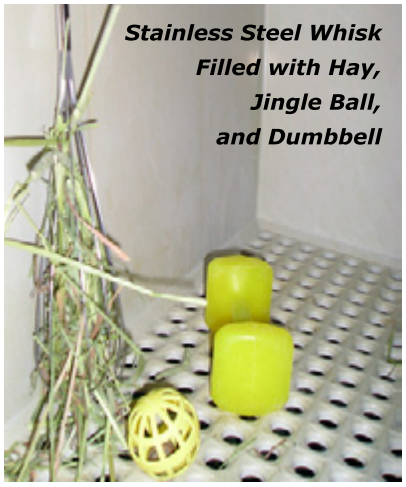
It's easy! It's free! It's a safe and secure place where you can say what's on your mind.

Click here to get started.

Nancy Johnson, DVM, MS, DACLAM, Southern Illinois University School of Medicine

Rabbit Enrichment: Summary of Current Options

The Veterinary Staff at our facility has been working on updating our enrichment program for all animals for which we care. We wanted to make sure our institutional policies were in line with new recommendations in the *Guide for the Care and Use of Laboratory Animals*, Eighth Edition. As our facility houses a small number of rabbits, we sent a request to the members of the Lab Animal community via CompMed, the Listserve affiliated with AALAS, which is an e-mail list for discussion of comparative medicine, laboratory animals, and topics related to biomedical research. We were interested in learning what was best from the personal experience of others in the field.



Stainless Steel Whisk Filled with Hay, Jingle Ball, and Dumbbell

We obtained 21 responses. In addition, we found some very useful resources. At least two posters at the 2011 AALAS meeting focused on rabbit enrichment (Posters 70 and 142). One respondent provided a link to the Royal Society for the Prevention of Cruelty to Animals and Universities Federation for Animal Welfare document "Refining Rabbit Care: A Resource for Those Working with Rabbits in Research".

To summarize the responses, most facilities used a combination of food treats and manipulable items (toys). Items designed for chewing or gnawing were popular, as these items stimulate the natural behavior of rabbits. Other common choices included small objects that the rabbit could pick up and toss around the cage. However, rabbits may show preferences for certain items, or become accustomed or bored easily. To overcome this difficulty, many facilities have several items for enrichment, and rotate them in and out of cages on a weekly schedule.

In addition to providing the enrichment, the staff of the animal care facility is required to document and review the enrichment program. The quality and benefit of enrichment should be reviewed on a regular basis by the IACUC, researchers, and veterinarian. How this recommendation from the *Guide* is implemented should be determined by the institution itself. This allows each facility to "tailor make" the appropriate program.

Environmental enrichment for laboratory animals should promote the well-being of animals and optimize the welfare of the animals by encouraging species-typical behavior. In addition, enrichment should not create unknown or unwanted variables for the research being performed.

Edible/food	Gnawing/chewing	Toy on chain	Toy in cage	Other
Hay*	Food grade cardboard tray	Ball chain*	Jingle Ball *	Resting shelves*
Hay cube*	Aspen wood blocks*	Nylabone	Rodent water bottle	Connected cages/pair housing
Banana chip	Cardboard boxes*	Bell*	Nylabone*	Play time in small child wading pools or play pen*
Papaya chip*	Fruit wood sticks	Triangle*	4" polypropylene ball*	Hut
Pinapple Bunny Blocks*	Paper towel tubes	Whisk (with hay)	Dumbbell toys *	
Wheat cereal *[1]	Large paper bags	Metal washers*	Rattle	
Fruit flavored cereal*[2]	Nylabone		Flexi keys*	
Fresh vegetables or fruit*[3]			Metal canning rings	
Yogurt drops			Shower curtain rings	

* Indicates multiple responses 1. Wheat Chex and Shredded Wheat 2. Apple Jacks and Fruit Loops 3. Kale, broccoli, carrots, parsley, cilantro, celery, apple

References

1. *The Guide for the Care and Use of Laboratory Animals*, 8th ed. 2011 Institute for Laboratory Animal Research,The National Academies Press.
2. *http://www.rspca.org.uk/researchrabbits*
3. http://www.bio-serv.com/category/Rabbit.html

Emily G. Patterson-Kane, Ph.D.

Animal Welfare Scientist, Animal Welfare Division, American Veterinary Medical Association (AVMA)

The clinical and field situations for humans and animals are increasingly bi-translational: the animal model can enrich our understanding of how health and well-being are created, supported, maintained, undermined and corrected; and by this same process, we become just a little closer to understanding what life is like for the research animal itself and how to make that—wherever possible—a life worth living.

Researcher, teacher, author, lecturer, keynote speaker and psychologist specializing in the human-animal bond, Dr. Emily Patterson-Kane, originally from New Zealand, now lives in Schaumburg, IL, with her (Scottish-born) dog, Avon, and several tanks full of freshwater fish. Spot, the goldfish, lives in her office, a costly but extremely important aquatic consultant.

For the past five years, Dr. Patterson-Kane has held the position of Animal Welfare Scientist in the Animal Welfare Division of the American Veterinary Medical Association (AVMA). AVMA is dedicated to improving animal and human health and advancing the science and art of veterinary medicine, including its relationship to public health, biological science, and agriculture. The AVMA Animal Welfare Division was established for the purpose of monitoring the science of animal welfare and assisting the Association in proactively addressing developing issues of animal well-being. Dr. Patterson-Kane is the first person to serve as an Animal Welfare Scientist in the division.

Dr. Patterson-Kane provides scientific support to the AVMA in the area of human-animal interactions, specifically animal welfare and the human-animal bond. She works with volunteer leadership and staff to identify and research related issues of importance to the veterinary profession and provides staff support to the Committee on the Human-Animal Bond; she also reviews scientific information and develops and maintains informational and educational materials and programs addressing animal welfare and the human-animal bond for use by veterinarians, governmental agencies, non-governmental organizations, media, and the public.

"I have a long-standing interest in supporting and encouraging good animal care and housing," Dr. Patterson-Kane says. "The scientific community produces a great deal of information on animal welfare issues, and I want to help the AVMA communicate this research to the people most interested in it. I think my position can serve as a bridge between the research community and communities grappling with animal use."

An advisory board member for *The Enrichment Record* and member of the review board for the *Journal for Critical Animal Studies*, Dr. Patterson-Kane also serves as a reviewer of manuscripts for the journals *Animal Welfare, Animal Behavior, Current*

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Directions in Psychological Science, Laboratory Animals, Journal of the American Association for Laboratory Animal Science, Lab Animal and *The Veterinary Record.*

Dr. Patterson-Kane received her Ph.D. degree in animal psychology from Victoria University of Wellington, New Zealand and her BSocSc and MSocSc degrees from the University of Waikato, where she first developed an interest in animal behavior. Prior to accepting her current position, she served as a postdoctoral researcher in animal sciences at Purdue University, research scientist studying sustainable livestock systems at the Scottish Agricultural College, postdoctoral research fellow in the animal welfare program at the University of British Columbia, and assistant professor and lecturer in psychology at Bradley University and Victoria University. Her research interests include environmental enrichment and human judgments of animal welfare. A frequent contributor to scientific journals, she is also co-author of the book *The Sciences of Animal Welfare*, released by Wiley Blackwell in 2009.

Focusing on Environmental Enrichment

Dr. Patterson-Kane originally looked at Environmental Enrichment as a theoretical issue: how early experience affects brain and behavior. And then a student question dramatically changed her perspective. "Are the rats happy?" the student asked. "Happy?" Dr. Patterson-thought. "Are the rats happy?!" She immediately started studying Environmental Enrichment, and animal preference and motivation studies have been a primary focus ever since.

"Everything is both complicated and simple," she says. "We need to solve the human part of enrichment. In some areas, we know how to enrich the animals…what we should be doing…but it's not happening. We have proved that Environmental Enrichment is necessary, but shouting doesn't work. We need to understand and respect why people are not providing enrichment… knowledge, funds, resistance to change…and fix that!"

Dr. Patterson-Kane sees a solution in the establishment of a new career, ***Enrichment Consultant***, ideally a full-time resource person who would be easily accessible to everyone working with animals. "An Enrichment Consultant," Dr. Patterson says,"will be able to identify problems, envision and inspire change, offer cost-effective techniques for implementing an enriching environment and maintaining compliance with guides and standards, and give people the opportunity to be in the right place…before they need to—with minimal disruption and utmost respect for the time and money of the institution!"

Thoughts on the Future of Environmental Enrichment

"Environmental Enrichment," Dr. Patterson-Kane says, "is a field that wants to cause its own extinction and just become part of everyday life." She looks forward to the day "when we don't say 'Environmental Enrichment' anymore, we just do it! That's good animal care."

Tim Allen, U.S. Department of Agriculture, Animal Welfare Information Center

The Science Behind Enrichment—A Look at the Literature

This month's *Enrichment Record* is taking a look at laboratory rabbits, so this short literature review will do likewise. The citations below are drawn from the literature published during the past few years and have tips on how to provide enrichment (even for regulatory studies!) and the effects on a disease model. A special thanks to CAB International (*www.cabi.org*) for permission to use abstracts for citations from their CAB Abstracts database.

Novel food items as environmental enrichment for rodents and rabbits
Brown C. (2009)
Lab Animal 38(4). ISSN:1548-4475 (online version).

Abstract: This column discusses the use of novel dietary supplements as environmental enrichment for rodents and rabbits. The purpose of enrichment is to encourage behaviors that are appropriate for a particular species and that satisfy an animal's physical and psychological needs.
Source: *Pubmed*
Descriptors: animal behavior; experimental animal; food animal; animal welfare

Environmental enrichment of laboratory animals used in regulatory toxicology studies
Dean, S.W. (1999)
Laboratory Animals 33(4): 309-327. ISSN:0023-6772.
NAL Call Number:QL55.A1L3

Abstract: There is a wealth of information in the published literature which describes a multitude of approaches to enriching the environment of laboratory animals. This paper attempts to review the various methods of enrichment through social contact, enhancement of the environment and diet, and improvements in husbandry. It attempts to place the various enrichment initiatives within the context of a laboratory which conducts regulatory toxicology, describes some of the experiences in the author's own laboratory and attempts to highlight those ideas which might prove practical to implement in the future. The aim is to demonstrate that a creative approach to environmental enrichment is indeed compatible with regulatory toxicology. It is hoped that this will encourage those responsible for the care and welfare of animals in

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such a laboratory to challenge historical practices and include environmental enrichment as a fundamental necessity of study design.
Source: *Agricola*
Descriptors: laboratory animals; laboratory mammals; Macaca mulatta; cages; monkeys; foraging; enrichment; environment; dogs; group size; toys; rabbits; floor pens; rats; mice; social dominance; floor type; pelleted feeds; guinea pigs; toxicology; animal welfare; literature reviews

Age-related behaviour on individually caged rabbits
Katsarou, A., A. Tsironi, M. Serafetinidou, C. Voyazaki, V. Baumans, and N. Kostomitsopoulos (2011)
Deltion Tes Ellenikes Kteniatrikes Etaireias—Journal of the Hellenic Veterinary Medical Society
62(1): 21-28. ISSN:1792-2720.

Abstract: Housing conditions and environmental enrichment of individually caged laboratory rabbits is of great importance for the welfare of the animals and the quality of the experimental results. In order to improve the design of existing environmental enrichment programs for laboratory rabbits, considerable knowledge of the behavioural needs of this species is necessary. Taking this into consideration, the aim of this study was to monitor and analyze the behaviour of juvenile and young adult rabbits in order to establish whether there are any age-dependent differences in grooming, rearing, sniffing, eating, drinking and gnawing. 12 NZW rabbits were divided into two groups: group A consisted of six 6-month-old rabbits (young adults) and group B consisted of six 2-month-old rabbits (juvenile). All animals were already housed for more than twenty days under the same conditions in the animal facility. Both groups of rabbits were video-recorded between 06:00 h-18:00 h for four consecutive days. The frequency of each behaviour was determined and compared in the two groups of rabbits from the video recordings. The frequencies of grooming, eating and gnawing in the young rabbits were significantly greater than those in the older rabbits (p{less than} 0.05). No statistical differences were found between the two groups for rearing, sniffing and drinking. From these results, we concluded that even small age differences should be taken into account when designing an environmental enrichment program for individually caged rabbits.
Source: *CAB Abstracts*
Descriptors: age; age differences; age groups; animal behaviour; animal welfare; cages; enrichment; environmental factors; feeding behaviour; grooming; laboratory animals; rabbit housing

The effect of social environment on markers of vascular oxidative stress and inflammation in the Watanabe heritable hyperlipidemic rabbit
Nation, D., J. Gonzales, A. Mendez, J. Zaias, A. Szeto, L. Brooks, Paredes J, A. D'Angola, N. Schneiderman, and P. McCabe (2008), *Psychosomatic Medicine*
70(3): 269-275. ISSN:1534-7796 (online version).

Abstract:
OBJECTIVE**:** Previous research demonstrated that social environment can influence progression of atherosclerosis in the Watanabe Heritable Hyperlipidemic (WHHL) rabbit. This study examined the effect of social environment on markers of oxidative stress and inflammation to clarify the physiological pathways potentially responsible for the influence of social environment on disease.

METHODS AND RESULTS: WHHL rabbits were assigned to 1 of 3 social groups: an unstable group, in which unfamiliar rabbits were paired daily, with the pairing switched each week; a stable group, in which littermates were paired daily; and an individually-caged group. The stable group engaged in more affiliative social behavior than the unstable group. The unstable group showed more agonistic behavior compared with the stable group and higher C-reactive protein levels than the individually caged group. The individually caged group was behaviorally sedentary, had higher 24-hour urinary catecholamine levels than the other groups, and exhibited higher NAD(P)H-oxidase activity in the aortic arch relative to the stable group.

CONCLUSIONS: The results suggest that social environment creates distinct behavioral contexts that can affect markers of inflammation and oxidative stress early in the development of atherosclerosis. Specifically, physical inactivity associated with individual caging affects indices of oxidative stress and inflammation. These pathophysiological markers may help to explain behaviorally related differences in the extent of atherosclerosis observed in prior studies.
Source: *Pubmed*
Descriptors: Agonistic Behavior, physiology, Angiotensin II, blood, Animals, Aorta, Thoracic, pathology, Arousal, physiology, Atherosclerosis, genetics, Athero-

sclerosis, pathology, Atherosclerosis, psychology, C-Reactive Protein, metabolism, Cholesterol, blood, Epinephrine, urine, Hyperlipidemias, genetics, Hyperlipidemias, pathology, Hyperlipidemias, psychology, Inflammation Mediators, blood, Lipoproteins, HDL, blood, Lipoproteins, LDL, blood, Male, NADPH Oxidase , blood, Norepinephrine, urine, Oxidative Stress, physiology, Peptidyl-Dipeptidase A, blood, Rabbits, Reactive Oxygen Species, blood, Receptor, Angiotensin, Type 1, blood, Social Environment, Social Isolation, Stress, Psychological, complications

Environmental enrichment of New Zealand White rabbits living in laboratory cages

Poggiagliolmi, S., S.L. Crowell-Davis, L.C. Alworth, and S.B. Harvey (2011)

Journal of Veterinary Behavior: Clinical Applications and Research 6(6): 343-350. ISSN:1558-7878.

Abstract: The primary goal of environmental enrichment should be the avoidance of abnormal behaviors in laboratory animals such as rodents, lagomorphs, dogs, cats, and nonhuman primates. A total of 13 male single-housed New Zealand White rabbits were offered 3 different toys, and the time spent chewing on the toys instead of on the cage was evaluated. Each rabbit was offered each of the toys for 2 separate 1-week periods. Each rabbit was monitored for 15 minutes 4 times a week for a total of total 1 hour per week. Observations included, 1-hour of baseline data before the toys were offered, for a total of 2 and 2 hours of observation per rabbit per toy. Having a toy available had a significant effect on the behavior of New Zealand White rabbits. Rabbits with toys spent significantly more time chewing than the rabbits without toys. They did not develop a preference between the offered toys and did not show stereotypies. This study highlights the importance of environmental enrichment to improve the welfare of laboratory animals.

Source: CAB Abstracts

Descriptors: animal behaviour; animal models; animal welfare; cages; enrichment; laboratory animals

Reporters Wanted!

In each issue of *The Enrichment Record* we report on Enrichment meetings and conferences in detail. We are seeking volunteers to write summaries of meetings, workshops, and conferences addressing any aspect of environmental enrichment for lab animals. Meeting organizers are welcome to assign a recorder. To request "Guidelines for Meeting Up Summaries," send your name, contact and meeting information to *info@theenrichmentrecord.com*

NAME_____

PHONE_____

EMAIL_____

EVENT _____

DATE_____

TIME_____

LOCATION_____

Meeting Announcement

Submission Form

Please submit the following information to Rhoda Weiner, *Editor* *rmbw19@verizon.net*

ORGANIZATION_____

CONTACT NAME_____

PHONE_____

EMAIL_____

DATE OF EVENT _____

TIME OF EVENT_____

\EVENT LOCATION_____

TYPE OF EVENT

Conference_____**Workshop** _____ **Lecture**_____

Meeting with featured speaker _____

BRIEF DESCRIPTION OF THE EVNT_____

_____

_____

Upcoming Meetings

Enrichment Extravaganza

April 24, 2012
Emory University, Atlanta, GA
8:30am—4:00pm

The Enrichment Extravaganza is a forum for new ideas and strategies on integrating innovation enrichment methods into the daily care of laboratory animals to enhance their welfare. This full-day event consists of a morning plenary session, posters and afternoon break-out workshops.

Keynote Topics:

One size does not fit all: Taking individual differences into account in behavioral management practices for non-human primates
Dr. Kristine Coleman, *Head, Behavioral Services • Oregon National Primate Research Center, Beaverton, OR*

Developing a Framework for an Environmental Enrichment Program for Laboratory Fish
Christian Lawrence, *Aquatic Resources Program Manager, Children's Hospital, Boston, MA*

Utilizing Environmental Enrichment as a Tool to Enhance Good Husbandry & Care for Rodents
Dr. Karen Froberg-Fejko,
President, BioServ, Frenchtown, NJ

Workshop Topics:
Rabbits, Mini-pigs, Swine & Sheep, Ferrets, Non-human primates, Canines, Mice & Rats, & Enrichment in a Tox Environment
For more information, contact
Denise Bianco at 908.228.2203 or
bianco@enrichmentrecord.com

Event Organizers:
The Enrichment Record, an online E-zine at *http://enrichmentrecord.com*
Yerkes National Primate Research Center

Animal Behavior Management Alliance 2012 Conference

May 6-11, 2012
San Francisco
San Francisco Airport Mariott

Join us in the Golden State of California to discover Behavioral Management Gold!

The 2012 ABMA conference will be held May 6-11th in beautiful San Francisco and will feature a key note address by Dr. Hal Markowitz, enrichment pioneer and author of *Behavioral Enrichment in the Zoo*. A 3-part enrichment workshop will also be presented by Dr. David Shepherdson, editor of the ground breaking book, *Second Nature*. In addition to exciting site visits to our Bay Area hosts Oakland Zoo, CuriOdyssey, California Academy of Sciences, and San Francisco Zoo, we'll host our usual bevy of fascinating presentations, posters, networking opportunities, and stimulating conversations.

The ABMA conferences typically offer CE credits for both certified dog trainers through the Certification Council for Professional Dog Trainers (CCPDT) and for behavior consultants through the International Association of Animal Behavior Consultants (IAABC). Please visit our conference site for information on registration, submitting presentation and poster abstracts, and additional conference details. See you in San Francisco!
http://theabma.org/index.php?option=com_content&view=category&layout=blog&id=62&Itemid=154--

If additional information or action is required, please feel free to contact:
Darren E. Minier, 2012 conference Chair, Animal Behavior Management Alliance
deminier@ucdavis.edu
or Margaret Rousser
margaret@oaklandzoo.org.

Recent advances in animal welfare science III

UFAW Animal Welfare Conference
June 21, 2012
York Merchant Adventurers' Hall
York, UK

As part of its on-going commitment to improving the way we understand and care for animals, the Universities Federation for Animal Welfare (UFAW) is pleased to announce the third of its series of unthemed one day conferences on 'Recent advances in animal welfare science'.

The conference aims to provide a forum at which the broad community of scientists, veterinarians and others concerned with animal welfare can come together to share knowledge and practice, discuss advances and exchange views. In keeping with this aim, registration for this meeting has been kept low—£25.00 (lunch not included).

Further details, including a registration form can be found on the UFAW website *http://www.ufaw.org.uk/conference2012.php*
Contact Information:
Stephen Wickens, Ph.D., Development Officer
The Old School, Brewhouse Hill, Wheathampstead, Hertfordshire, AL4 8AN, UK
Email: wickens@ufaw.org.uk
Direct tel/fax: +(0)1276 500880
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Registered Charity No 207996 (Registered in England) and Company Limited by Guarantee No 579991
The Universities Federation for Animal Welfare (UFAW) is an independent registered UK charity that works to develop and promote improvements in the welfare of all animals through scientific and educational activity worldwide.

Harmonisation of the Care and Use of Agricultural Animals in Research

September 26-28, 2012
Gardermoen Airport, Oslo, Norway

This meeting offers state-of-the-art lectures from internationally recognised experts within agricultural animal science and will provide an update on current knowledge as well as an opportunity to discuss research needs in an informal atmosphere.
Topics will include, but not be limited to:

- Update on changes in European legislation and international guidelines
- Positive welfare indicators
- Husbandry and environmental enrichment
- Humane endpoints
- Update on the latest research in comparative medicine
- Groupwork to produce a consensus statement on the way ahead, including research needs

Electronic registration is now open for this international consensus meeting. Please use this link:

http://www.norecopa.no/sider/tekst.asp?side=21

Norecopa is the Norwegian Consensus Platform for Replacement, Reduction and Refinement of animal experiments.

REMEMBER:
Please send notification of your Upcoming Meetings to Rhoda Weiner at *rmbw19@verizon.net*

THE Enrichment RECORD

The Enrichment Record is a quarterly E-Zine created by the Laboratory Animal Research Community as an online forum for:

- Discussing environmenta enrichment in the optimal care of laboratory animals
- Documenting best practices
- Sharing data on the impact of environmental enrichment on the science
- Building the case for integrating enrichment into research design