THE SHAPE OF ENRICHMENT
A Quarterly Source of Ideas for Enrichment

The Homemade "UniverZOO" Ball

By Miklós Faludi, Budapest Zoo, Hungary

Budapest Zoo has had elephants for nearly 150 years. Animal keeping and caretaking practices have changed over time, but today, enrichment is a basic element of zookeeping. There are many ideas and tools. However, for many zoos, budgets are limited. Keepers have to be smart in finding and implementing new ideas, in order to avoid repeating the same enrichment methods too often.

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Asian elephant Assam tries out his tire ball.

During the 2nd SHAPE—South and East Europe Enrichment Workshop in Hungary, a picture was shown of a "tire ball" designed and made for rhinos at the National Zoological Gardens of Pretoria. I was inspired by this idea, and contacted them to send me the details of the ball. However, I realized that we couldn't make it at our zoo—it was too big and heavy and required special tools we didn't have. Yet making a heavy-duty ball for our elephants remained part of the keeper's discussions.

We knew what we wanted, and listed what we had to work with. From this, we created version 1 of the ball. We used 5 tires, each 60 cm in diameter and 20 cm in width, and cut them in half. We then bolted the ends of the halves together and overlapped them to form a rugby ball shape. Then we used two additional tire halves and bolted them on the ball's sides to make the ball more solid. We finished by cutting down the ends of the bolts and rounding them to avoid possible injury.

Then we gave the ball to our male elephant, Assam, to play with, and watched. Unfortunately, after 1.5 hours, the ball started to get weak where the tire sides were bolted together, and we had to remove the ball to avoid possible injury. We needed to find a way to make the ball more solid but flexible, able to stand up to a four-ton animal's weight and force. Version 2 was born two weeks later, created in a shorter time and using even less materials. This time we used 4 tires, plus: 12 M8 screws and nuts, 24 M8 extra-big washers, 2 M10 screws and nuts, and 4 M10 extra-big washers.

Step 1: The first tire was left as is, no cuts or modifications. It is important to choose tires without any damage on the surface or sidewalls. This whole tire provided the solid core for the ball.

Step 2: Then we took the second tire and cut four notches on its sidewall, two on each side, but left the outer surface intact (see photo on next page). These notches allowed the two tires' outer surfaces to connect, and they would be bolted together. The outer surface is the strongest part of the tire, so if we drill and bolt them here, they will be able to resist greater forces. The tire with the notches was pushed/forced around the intact tire and connected by two screws. Due to the steel belts and ply cords embedded in the rubber, the drill to make the hole for the screws had to be twice as big as the screw itself, making it easier to hammer through the screws on the outer surfaces.

Step 3: Then we cut the whole sidewall off the third and fourth tires, leaving the outer surfaces in one continous ring (see photo on next page). The two already bolted tires were starting to look like a sphere, so all we had to do is to force these two rings, one at a time, around the already connected tires. The final result was a sturdy tire ball.

With the M8 screws, nuts, and washers, the individual rings were connected to the inner complete tire. Finally, on the two points where all four tire outer surfaces were lying on top of each other, the bigger and stronger screws were used; one on

each side seemed to be enough.

For animal safety reasons and to increase the life of the ball, the screw heads had to be inside, and the length of the screws had to be reduced: we cut them right above the nuts, and rounded them carefully, to remove sharp edges.

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Top: Step 2, notch cut in one tire. Bottom: Step 3, sidewalls cut off two tires, ready to push onto the others.

This version of the ball immediately looked more solid. We could hardly wait to test it, and Assam was chosen to try it out again. The result exceeded our expectations: immediate success. After five minutes, Assam layed on the ball with all his weight, but when he stood up, the ball jumped back to its original size and shape. Assam loved his ball and interacted with it for three hours. He kicked, lifted, pushed, smashed, stepped, and layed on it. Even when he was eating, the ball was near him, and he touched it with his trunk to make sure it was there.

After this three hours of heavy-duty testing, we managed to get the ball out of the exhibit and examined it closely: it had suffered absolutely no damage at all! Version 2 was a success. Another one just like it was made and introduced to the elephant cows.

Budapest Zoo

Assam wouldn't leave the ball for three hours, even while eating.

Keepers on the other sections liked the balls as well. And we noted that on the third day after introducing the balls, visitors started looking for the elephants playing with the them—the news was spreading.

The balls became a regular part of the elephant enrichment. We started using them for feeding purposes as well, putting hay, fruits, and vegetables inside. Every time the elephants see the ball—even just from outside—they show excitement and eagerness. It's now been seven months, and the balls are still intact, without any damage or wear, and so far they are one of the most successful and most popular enrichment items we have created for our elephants.

We received a request from the Big Cats & Carnivores section: they wanted to try out this ball with the three nine-month-old Siberian tiger cubs. They are so playful and wild that hardly any enrichment tool or object can survive. A tire ball was made for them, and it was a big hit. The three cubs were immediately on the top of the ball, which was attached to a tree: playing, chasing, tearing, biting it, even more so when the ball had meat inside. The public was fascinated watching them, and the cubs were more active during the daytime.

Then it was the polar bear's turn: the keepers wanted to try out the ball with the female, Tanya. She is so addicted to her ball that she brings it up from the bottom of her pool and plays with it on land and in the water, whether or not it has meat or fish in it.

This ball has proven to be a multi-species and multi-functional enrichment item. The ball encourages exercise, stimulates natural behaviors, and can be used as a feeding tool. Three different species can use the same tool, and we are planning to introduce it to more, finding new ways and ideas of using it. It is a real "UniverZoo Ball" that lasts. Our zoo management has also acknowledged its success: even though the ball is not made from natural materials, because of its simple, inexpensive, "handmade" style and the keepers' enthusiasm they have embraced its use.

In short, this adaptation of the enrichment ball idea has been successful for us because:

- Inexpensive, recycled materials were used
- It can be made in a short time without a lot of effort, and is a team-building experience for the keepers
- It only requires a basic investment for the screws, nuts, and washers; the needed tools are part of a general workshop
- It is universal—it works for feeding or playing; can be hung or attached or left untethered; and be can be used by different species.

We are very pleased with this adaptation of the enrichment ball idea. No more boring or average weekdays in the elephant, tiger, and polar bear exhibits! ✧

Environmental Enrichment in Behavior-based Bear Husbandry, Part 1: Principles

By Else M.B. Poulsen, Consultant, Behavioral & Environmental Solutions, Toronto, Canada

Look for Parts 2, 3, and 4 of this article series in upcoming issues

Environmental enrichment is a critical and inextricable component of behavior-based bear husbandry. To understand how the two work together to promote the mental and physical welfare of bears, one has to go back to the roots of behavior-based bear husbandry. Historically, the term husbandry referred to the care and breeding of livestock, and was exclusively focused on the human agenda. Over time, collections of captive wildlife kept for the enjoyment of humans became popular first with the dynastic and the wealthy, and then with the public. The care of wildlife in zoos became expressions of societal mores.

John Neuman

Having little to no information on the natural history of most species, post-war Europeans and North Americans became entranced with single-issue husbandry styles. Great apes were housed in pairs in tiled showrooms for easy disinfection, since killing bacteria had become the new paradigm for human health. Large carnivores, including bears, were also kept in pairs and housed in thick cement grottos or pits, because they were dangerous and we were afraid of them. We were also afraid for them, so there was nothing in the enclosure to interact with lest they should hurt themselves. By the 1970s it became clear that these sensory-deprived animals were not thriving, since the majority exhibited some form of aberrant and/or repetitive behaviors. In fact, the sight of a pacing polar bear at the local zoo was so common that the Dutch language contains the verb *ijsberen* (to polar bear) meaning to pace up and down (Poulsen, 1996).

There was a brief interlude of common sense that lasted until the late '80s where zoo designers built natural environments for wildlife befitting their species-specific needs. This focus on the animal agenda was fuelled by a resurgence of interest in Heini Hediger's (Hediger, 1950) writings. Hediger had been the director of the Tierpark Dählhölzli Zoo, the Basle Zoo, and the Zürich Zoo, and was an ethology professor at the University of Zurich. Today, he is considered to be the father of zoo biology. Bears and other wildlife took full advantage of their natural surroundings and predictably disappeared into the foliage. But all was not well. Zoogoers were dissatisfied with the fact that they could not see the animals that they had paid admission to view. In an attempt to remedy this, the focus changed again from the animal agenda to the human agenda and "naturalistic" habitats were born as part of immersion exhibitry that gave visitors the sense of being in the animals' habitats. Some of these enclosures were more successful than others, and wildlife again showed difficulty adapting to an increase in cement structures and a decrease in space. In this period of fluctuating focus from the human agenda to the animal agenda and back again, zoos have become dotted with varying enclosure designs in need of enhancement to better the living experience of the wildlife they house.

Behavior-based husbandry and environmental enrichment evolved as our understanding of the natural history of individual species grew, highlighting the need for increased complexity in captive environments. Initially behavior-based husbandry techniques and enrichment events were applied like Band-Aids to targeted animals exhibiting aberrant behaviors. Each effort created a pixel of insight into the big picture of that species' behavioral repertoire. We learned that mimicking a bear's natural habitat and the ingredients to express its daily and seasonal activity patterns

reduced the stressors inherent in captivity and promoted mental and physical well-being.

Behavior-based husbandry is the deliberate provision of species-specific, internal and external care to animals befitting their genetic and circumstantial expectations. It is focused on the animals' agenda and holistically includes enclosure design and furniture, diet presentation and nutrition, care and maintenance routines, caregiver and animal relationship building, communication (e.g. operant conditioning), ambient parameters (e.g. photoperiod, temperature, sound), and veterinary care (Poulsen, 2011). Environmental enrichment can be understood in two complimentary, interdependent ways: the inherent complexity of natural or naturalistically provisioned enclosures and the addition of daily or seasonal complexity mimicking those biophysical features that appear ephemerally in the animals' wild habitat. The elements of a bear's natural environment fall into one of three categories: permanent structures such as boulders, trees, and rivers; ephemeral structures or events such as streams, photoperiod, seasonal appearance, or food resources; and those events that change constantly, such as some food resources and ease of catch (Poulsen, 1994). Successful behavior-based husbandry relies on an understanding of how a bear uses these structures and events in its daily and seasonal routines to ensure individual and species survival.

Table I Daily Husbandry Routine for Kermode Bears from Early Spring to Late Fall

TIME	WILD BEHAVIOR	ENCLOSURE/ENRICHMENT REQUIREMENTS
Sunrise	Bear wakes - stretches	- Bears need constant indoor/outdoor access, except for enclosure maintenance and enrichment. - Bears often rise long before caregivers arrive for work.
"	Bear checks status of companion animals i.e. cubs, mate, companions	- Bears must live in appropriate social groups befitting their age, sex, and reproductive status; it is generally recognized that one male to two or more females results in the most peaceable group.
"	Bear cleans in water or substrate	- Bears must have access to pools, woodchips, soil, growing grasses, substrates in significant amounts to accommodate personal hygiene.
"	Bear drinks	- Bears must have access to clean potable water.
Early A.M.	Bear begins morning search for food	- This is a critical time for a bear, since his food search often begins before the caregiver arrives in the morning. A hungry bear in a food-deficient enclosure may express anticipatory or entrenched stereotypies; thus food must be available either in feeder devices, via an early caregiver shift available at sunrise, or via automated feeders. - Automated feeders can cause behavioral issues if used throughout the day as a substitute for a variety of enrichment events; however when used exclusively in the early morning to provide food to hungry bears, the method can prevent the onset of stereotypies.
Early-Mid A.M.	Bear's search for food continues	- Caregivers must have the ability to recall and shift the bear into another area using either personal relationship or operant conditioning to accommodate morning maintenance. - While the caregiver is cleaning and enriching exhibit areas, the bear must be kept stimulated for the entire duration that he is confined in the back areas with food enrichment until he can be released into the exhibit area. - This can be a good time to do operant conditioning, provided the bear has had a chance to eat to at least partially satiate itself. - It is imperative that the bear use a quantitative method to assess satiation, such as the bear leaving food, since a bear that eats all of his food does not indicate satiation and could indicate hunger. - The objective of the A.M. feed is to satiate the bear; thus enrichment offered should be interesting but not so challenging as to be frustrating. The challenge of food extraction in enrichment can be increased in the afternoon when the bear is interested in the activity and less concerned about satiation.
Mid A.M. – Early Afternoon	Bears choose and prepare a daybed site, and take a nap	- Bears will take an early afternoon nap, for which each bear requires a choice of private daybed sites, nesting material (straw, woodchips, excelsior [wood wool] etc.), ability to adjust body temperature (shade, sun), undisturbed down time (no training sessions or required public appearances).
Mid Afternoon	Bears rise to continue food search	- Caregivers lock bear into enriched back area to place enrichment into main outdoor enclosures. - Caregivers can do operant conditioning or relationship building sessions with bear
Afternoon - early evening	Bears continue food search	- At this time enrichment can offer greater mental challenge, novel items, foodless enrichment, and scent enrichment. - Enrichment that offers group activity such as wobble trees work well at this time, since satiated bears are 1) less likely to take personal ownership of event; 2) more likely to tolerate group efforts to solve problem; and 3) be disinclined to exhibit aggressive behavior. - Jungle gyms that allow hanging items or climbing opportunities provide bears with exercise if enrichment is used to entice bears into activity.
Early evening	Bears continue food search but begin to search out site for bedding down for the night	- Caregivers can either bring bears into enriched back area to accommodate the enrichment of the exhibit enclosure, or they can throw enrichment items over fencing or send it down through delivery pipes. - The enclosure must provide enough bedding and private areas for each bear to comfortably bed down for the evening.
Night	Bears rest. On occasion bears become nocturnal usually to forage unhindered by either conspecifics or predatory species	- Bears should be monitored to assess if any group members habitually become nocturnal feeders, as this can indicate that this bear is not competing well with more dominant members of the group.

Bears are sentient animals born with a set of genetically encoded expectations to live a life specific to the habitat they were born to occupy. Thus they have expectations that their morphology and understanding of how to find food, mates, and lodging will work with the environmental opportunities around them. In other words, a bear does not have a genetic expectation to jump like a kangaroo, use his tail for locomotion, or nurture young in a portable sack. The further their environment veers away from their expectations, the more difficult it is to adapt, and the greater their stress level. In addition, bears have expectations based on their individual history and their current environment specific to their age, sex, and social condition.


John Neuman

Consider the photographs accompanying this article. This is a Kermode bear living in Canada's northern rain forest in British Columbia. The Kermode or spirit bear is the white phase American black bear (*Ursus americanus kermodei*) thought to be a genetic anomaly brought about by a double-recessive gene. Current research seems to indicate that having white fur may be a distinct advantage when catching salmon, as white is less visible to the fish against the colors of the sky when they

look up. Thus we may be witnessing evolution in progress (McCrory, 2013). The number of combinations and permutations of the biophysical structures and events in this habitat are astronomical, affecting the bears' every sense and ability: sight, sound, taste, touch, smell, thinking, focus, moisture, balance, emotion, hunger, movement, success, problem solving, and the list goes on. The American black bear and all other species of bear are genetically programmed for such profound environmental complexity. This should put the single enrichment event offered per day in an otherwise stagnant enclosure into its proper perspective. It's not enough for such incredibly perceptive creatures.

Table II Seasonal Husbandry Routine for Kermode Bears

SEASON	
FALL Hyperphagia	**WILD BEHAVIOR**
	The Kermode bear will be a voracious eater at this time of year, as his objective is to gain fat reserves to see him through the upcoming winter denning period and his walking metabolic depression in the ensuing early spring. Berries, fruits, nuts, and meat proteins (e.g. salmon) make up the majority of his fall diet. As winter nears, the bear alternates his time between feeding grounds and inspecting possible winter denning sites, eventually choosing one site to either build or renovate.
	ENCLOSURE/ENRICHMENT REQUIREMENTS
	The bear's diet must be increased according to his appetite not according to an artificial weight gain goal set for him by managers which could leave him calorie deficient and unable to manage properly through the upcoming winter. A bear that is not yet in metabolic depression and has had food resources decreased artificially can starve and die. Metabolic depression is complicated and not wholly understood, thus the bear knows best how many calories are required to survive an upcoming winter. Wild bears have been observed to walk off of feeding grounds when they are ready to den even when there are still berries and other food resources left, suggesting that food availability is not the only critical criteria signalling denning fitness. Bears will need a great deal of enrichment, which could include scatter feeds, puzzle feeders, lunch boxes and bags, rotting logs with bugs, and fresh browse such as willow. A choice of winter denning sites and bedding material should be available early on, so the bears can move from one to the other and assess suitability.
WINTER Denning	**WILD BEHAVIOR**
	American black bears hibernate for the winter months, even those bears that live in warmer climates such as Florida. The duration of the denning period depends on numerous criteria including biophysical parameters, age, and sex.
	ENCLOSURE/ENRICHMENT REQUIREMENTS
	A bear in metabolic depression experiences a 20-50% decrease in metabolism, reduction in heart rate from 40 b.p.m. to 8-10 b.p.m., a decrease in oxygen consumption up to 50%, and a slightly depressed body temperature to 86-95˚F. A captive bear that is not given the opportunity to den becomes slow moving, often short tempered and unable to successfully take part in operant conditioning or other husbandry procedures. A bear requires a cool, dark, quiet, private place to den up with a large quantity of bedding material. It is imperative to set up a food and water depot near the bear's chosen denning site, since managers will not know if a particular bear was able to effectively compete with other bears for food resources and if he carries the necessary fat reserves for denning. Since bears will actually get up from denning for preferred foods and enrichment items, all treats and enrichment are to stop during denning to allow the bear undisturbed hibernation. The best food to leave at a food depot is pelleted omnivore chow. Generally, it is not a preferred food, and bears do not tend to rise to eat it unless they are nutritionally or fat deficient.
SPRING Walking Hibernation	**WILD BEHAVIOR**
	The bear gets up in the early spring when the weather warms up slightly and the ice and snow are melting. At this time, there is no new growth available to them, thus they root around to find overwintered berries, nuts, and the carcasses of animals that died during the winter. Foods are still scarce and their food intake is not high. Bear go through metabolic depression for the next several days to several weeks in a "walking hibernation." Thus the bear is still relying on fat reserves.
	ENCLOSURE/ENRICHMENT REQUIREMENTS
	The bear must not come out of his denning period bone thin. He must be carrying fat reserves to get him through his walking hibernation period. The bear's diet presentation must mimic the appearance of foods in the wild, and the caloric intake must be slowly increased up to the summer and then dramatically increased the following fall. The bear will need a great deal of enrichment throughout the day to occupy his time and will require bedding materials.
SUMMER	**WILD BEHAVIOR**
	The bear spends the late spring to early summer occupied with reproduction. When breeding season wanes, the bear begins to follow the appearance of food resources such as fish spawning, larval phases of insects, and berry production.
	ENCLOSURE/ENRICHMENT REQUIREMENTS
	The bear's diet presentation must mimic the appearance of foods in the wild and the caloric intake must be fully restored to summer capacity. The bear will need a great deal of enrichment throughout the day to occupy his time, and will require bedding materials.

So how does one begin to develop a behavior-based bear husbandry program incorporating enrichment? By importing the information we have about the wild bear's daily routine into the captive environment. Tables I and II delineate how to set up a daily and seasonal husbandry routine befitting a Kermode bear [American black bear]. Bear species differ widely in their adaptations to varying niches. For example, the sun bear (*Helarctos malayanus*), frequently described as the "chimpanzee" of the bear world, is a small, tropical, often arboreal, highly insectivorous, omnivorous bear requiring an aseasonal warm temperature range, significant climbing structures, intricately varied diet, and a well-vegetated, complex captive environment. In comparison, the brown bear (*Ursus arctos*), a large, temperate, terrestrial, frequently vegetarian, omnivorous bear, closely related to the polar bear, requires a complex and geomorphically diverse captive environment, which includes seasonal diet and temperature changes that accommodate fall hyperphagia followed by winter hibernation needs.


John Neuman

Often there are inherent differences between the geophysical parameters of the bear's native habitat and the zoo's location. These can be overcome by assessing how a bear might be genetically adapted to deal with it in the wild. For example, few Andean bears (*Tremarctos ornatus*) experience freezing temperatures, with the exception of those bears that periodically move through the higher elevations of the Andes mountains. In the tradition of old school husbandry, it was common to attempt to *acclimate* Andean bears to winter temperatures inherent in zoos located in temperate zones by maintaining building temperatures at just above freezing. As a result, cold Andean bears nested as high up in the rafters of their buildings as possible and stayed there most of the winter in an attempt to stay warm. They rarely ventured outside or moved from the warmest spot in their building enclosures, thus they were frequently off exhibit. Using the principles of behavior-based husbandry, this problem was solved by increasing the building

enclosure temperature so that the bears were comfortable, and installing door flaps to keep the warm air inside. As a result, Andean bears became active in the winter, often running outside to play in the snow for short jaunts, knowing that they could go back inside at will to warm up and dry out. In this case, daily enrichment programming is needed year-round, as the bears remain active throughout the year.


John Neuman

Polar bears (*Ursus maritimus*) are another bear species highly adapted to an extreme environment, occupying niches in the Arctic Circle. Fortunately, several subpopulations living in the southern Hudson's Bay area experience seasonality. It is the behavior of these bears that give zoo managers information about how polar bears can be successfully housed in temperate climates. These bears go through an annual cycle opposite to that of the brown bear. These polar bears gain weight in the winter months and lose weight in the summer months, experiencing a walking hibernation while waiting for the bay to freeze in the fall, allowing them to again migrate to their traditional hunting grounds on the pack ice. Some bears become omnivorous feeders in the summer while others fast. Gravid females begin a weight loss in the summer that lasts through the following spring when she brings her newborn cubs to the pack ice in the north. She begins by digging an earthen cave into the side of a river bank on the tundra, later adding a snow room in the winter after the snow has accumulated on the hillside. By mimicking diet changes and presentation through enrichment programming, thereby allowing proper weight loss and gains at the appropriate times, these bears can thrive year round.

To further the discussion on utilizing enrichment programming in behavior-based bear husbandry, three additional parts to this article will follow in upcoming issues of *Shape*, including the following topics: enrichment in behavior-based bear diets and nutrition; enrichment and behavior-based bear denning; and the importance of enrichment in behavior-based bear integrations. ✧

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12th International Conference on Environmental Enrichment, 2015, Beijing, China

The 12th ICEE will be jointly held by Beijing Normal University and Beijing Zoo from May 24 to 28 in 2015. The conference website, iceebj.bjzoo.com, has been set up and is ready for your reference and registration. The deadline for early bird registration is January 31, 2015; regular registration is from February 1, 2015 to March 10, 2015. If you would like to present a paper, abstracts are due March 10, 2015. Information concerning the conference venue and important dates can currently be found on this website; information about pricing, accommodations, the program, and other updates will be posted as they become available, so please continue to check back. We welcome you to Beijing in 2015.

—Dingzhen Liu, Executive Chairman of 12th ICEE

Fire Hose Feeder Cube

By Luke Siberrry, Keeper, Aspinall Foundation, Kent, UK

Since its invention in 1673 (Crosby 1905 and Sutton, 2006), fire hose has helped fight innumerable fires and save lives. Over several hundred years, the use of different materials and construction methods have led to the development of stronger and more durable fire hose. Once a length of modern fire hose has reached its life expectancy, it can start a second life in zoos. Fire hose has become a staple in many animal enclosures across the world; it is strong, flexible, and durable, making it the perfect material for fabricating enrichment items (Cowan & Trust, 1997, Hare & Jarand, 1998).

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From top to bottom: Figures 1, 2, and 3.

The fire hose feeder cube (Fig. 1) was developed as a food-based enrichment item to be used primarily with primates. Its design is simple and easily replicated; it is composed of a fire hose cube with a hole drilled into the top. This hole allows for food to be placed inside the cube yet is small enough to make the animal work to retrieve the food. This item was initially used with a troop of Guinea baboons and a group of lion-tailed macaques. Both trials were successful, and these pieces are now in regular use in the primate sections at both Howletts and Port Lympne Wild Animal Parks.

Producing these feeder cubes is easy provided you have time, manpower, and equipment. Just follow this step-by-step guide to making fire hose cubes.

Step 1: Calculate lengths of fire hose

The width and thickness of the fire hose used is very important, as these factors determine the length of fire hose required to form a cube that isn't too tight but is also not too loose.

It may seem obvious, but the width of your fire hose is important: each face of the cube is as long as it is wide. Four sides means a length of fire hose has to be at least four times the width of the fire hose that you are using. Thickness is important, as the thicker the fire hose the more leeway is needed when bending it around corners. For thin fire hose, you may only need 1cm leeway for each corner; for thicker hose, you may need 2cm or more per corner. The more you have, the easier the cube is to manipulate; for beginners 2cm allows greater dexterity regardless of thickness; 5cm is added to the calculated length to leave a little extra fire hose to overlap once bolted.

The length of hose is calculated using: (Width + (1 or 2 cm)) x 4 + 5. Each cube requires three lengths of fire hose. So, if your fire hose is 11cm wide and it is thick, the lengths of fire hose should all be 57cm long (Fig. 2). A serrated knife or heavy-duty scissors should be sufficient for cutting your lengths to size.

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Clockwise from left: Figures 4a, 4b, 4c, and 4d.

Step 2: Drill a hole at each end

Use a 10mm drill bit and power drill to drill one hole at each end of the lengths of fire hose. These holes should be drilled in the middle and about 2.5cm away from the end (Fig. 3). The distance from the cut edge of the length of hose to the hole is half of the 5cm that was added as overlap. This value can vary depending on the amount of overlap you wish to use.

Step 3: Bolt two of the lengths

Take one length; curl it around to form a circle

with the drilled holes overlapping (Fig. 4a). Then place a bolt with a washer through both holes and place another washer and a nut on the other side. Tighten bolt with a socket wrench while holding the nut in place with the spanner. Repeat this process with one more length (Fig. 4b).

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Clockwise from upper left: Figures 5a, 5b, 5c, and 5d.

Step 4: Start forming the cube

At this point two of the lengths should form rings, and the final length will be unbolted. Insert one ring inside the other ensuring the bolt of the internal ring is hidden under the external one (Fig. 4c and 4d).

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Clockwise from upper left: Figures 6a, 6b, 6c, and 6d.

Once the bolt is hidden successfully, weave the final length through the two rings (Fig. 5a). This final length needs to be woven over the external ring and under the internal ring (Fig 5b). When both ends of the final length are sticking out on one side of the cube (Fig. 5c), bolt the ends together (Fig. 5d); this will secure the cube.

Step 5: Marking and drilling the opening

To describe this step the external ring is referred to as A, the internal ring as B, and the length as C. Drill the hole on a face of the cube where A and B overlap but doesn't contain a hidden bolt.

Once you have identified the appropriate face you need to make sure the bolted face of A is neat and hidden. Once you are happy that A is in the correct position mark the centre of the face that you will drill into. Mark the internal and external rings (Fig. 6a) as it is important they are re-assembled in the same position.

Take the cube apart and unbolt ring A (Fig. 6b). Once unbolted lay it flat, drill a hole with the hole saw at the spot marked earlier. Bolt A back together and reassemble the cube by placing B into A and weaving C back through. Check that the bolts on A and B are hidden. Then, through the hole that was drilled into ring A, mark ring B. This is where you will drill the final hole.

Again take the cube apart, unbolt ring B. Lay it flat and drill a hole through the marked area using a hole saw. Reassemble the cube, making sure that the hole drilled in ring B lines up with the hole in ring A (Fig. 6c). Weave length C through the two rings and bolt C together (Fig. 6d).

Step 6: Neaten up

The last step is to hide the bolt on the final ring. This can be the hardest step and requires the most effort depending on how tight your cube is. Work the fire hose around by pulling all the slack to one side of the cube then feeding the slack through to the other side, shimmying the ring around to the point that the bolt is hidden (see Fig. 1).

Now your fire hose cube is complete and ready to be filled with food and thrown in for the animals. To make a number of these cubes, you could undo one and use the three lengths as templates to mass produce these useful enrichment items. ✧

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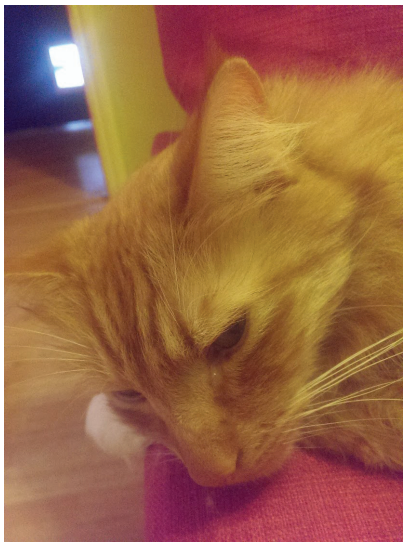
Soothing the Savage Beast: The Effect of Auditory Enrichment on Domestic Cats

By Gina Stephens and V. Tamara Montrose, Department of Animal and Land Sciences, UWE Hartpury, UK

In the UK and abroad, large numbers of domestic cats are housed in confined conditions such as rescue shelters, laboratories, boarding catteries or home environments. Confined conditions can frequently be under-stimulating and stressful for the animals concerned. Methods to enhance welfare are therefore of paramount importance.

Auditory stimulation is a form of sensory enrichment that can include sounds of conspecifics, natural habitat sounds, and music. Auditory stimulation has been demonstrated to be effective in reducing stress and enhancing a natural behavioral repertoire in a range of species, including lar gibbons, African leopards, dogs, pigs, Asian elephants, and western lowland gorillas. While auditory stimulation has not been shown to be beneficial in all species, it does have the potential to improve the welfare of some species in a captive setting. The use of music is also a feasible, relatively cheap and easy element to implement in captive environments.



Little is currently known about the benefits of auditory stimulation in domestic cats. We therefore aimed to determine whether the provision of music would enhance the behavioral repertoire and welfare of captive cats housed in an animal rescue centre.

Methods

The study was conducted at Cheltenham Animal Rescue Centre. Fourteen individuals were included within the study with a range of ages, genders, and breeds, creating a representative sample of cats admitted to the rescue center.

Five conditions of auditory stimulation were tested. This included a control period, in which no music was played at all, and four periods of different music genres: classical, rock, pop, and jazz. Music selected for this project included musical collections for each genre.

The observations were conducted while individuals were contained within their enclosures, with the source of music played from the corridor adjacent. Observations were conducted during two-hour slots between the hours of 11 a.m. and 4 p.m. during weekdays in order to try to avoid variables such as feeding times and cleaning regimes.

Ten hours of observation for each music genre occurred over a six-week period. Instantaneous scan sampling at 3 minute intervals was used to record the frequency of behaviors displayed for each auditory condition. This was done using an ethogram with the behavior categories of standing, eating, sleeping, lying, walking, grooming, vocalizing, and playing.

Results

Auditory stimulation was found to have an effect upon the frequency of eating and vocalization behaviors performed by the cats. Cats displayed a higher frequency of eating behaviors in the control condition than the rock, jazz, or classical conditions.

Cats also exhibited more vocalization behaviors in the control condition than the rock condition. No significant differences were found for the other behaviors displayed in the different auditory conditions.

Discussion

A greater frequency of eating behaviors could indicate enhanced welfare, showing a relaxation of vigilance in threat monitoring behavior that allows the cat to spend time feeding. However, increased eating can also act as a coping mechanism for environmental stress. Vocalizations can indicate a variety of states in cats, including angry, friendly or fearful emotions. Because the purpose of the feeding and vocalizing behaviors were ambiguous, the findings of this study are inconclusive. In contrast to research in other species, no clear enriching effect of auditory stimulation was found for the cats in this study.

We do think that there are potential benefits of music as environmental enrichment in captive cats, however, and would like to see further study to elucidate this topic. ✧

Anteaters Lapping Up the Attention!

By Mark Kingston Jones, The Shape of Enrichment, and Chris Hales and Shelley Ansell, Howletts Wild Animal Park, Kent, UK

Howletts Wild Animal Park in Kent houses giant anteaters (*Myrmecophaga tridactyla*), and the keepers strive to create a holistic enrichment program for them. One of our original goals was to create enrichment that allowed them to use their fantastic tongue-flicking adaptation. With this in mind, a prototype was made, inspired by a pot dipping enrichment device that was used to encourage tool-use behavior in primates.

Mark Kingston-Jones

Above: Female anteater extracting food from the film cannisters on the device while her baby looks on. Right: First version of the device was mounted on the mesh of the enclosure.

The materials were all readily available and included a sheet of scrap Perspex, camera film canisters donated from local film processing shops, and small- and large-gauge cable ties. The Perspex sheet and lids from the film canisters were drilled with corresponding holes: one 10mm hole in the center and two smaller holes above or below the center hole, just big enough to loop small gauge cables ties through, thereby tightly attaching the canister lid to the back of the sheet. Glue around the rim of the lids had been considered as an alternative attachment method, but that was rejected as a safety concern in case of any contact with the food or tongue. The canisters could then be filled with food items and snapped back onto the lids. The front of the Perspex sheet was attached onto the outside of the enclosure mesh fence, facing inward, using large gauge cable ties for strength. The resulting device required the anteaters to stick their tongues through the 10mm holes to extract the food inside the cannisters.

Mark Kingston-Jones

Although small scale, the device worked well, and the anteaters were observed exploring the device, sniffing at the holes, and then extracting the food through repeated tongue flicks (video available—see URL in references). The anteaters were also observed returning to the emptied pots, presumably because they all still smelled of the food they had contained, and the animals were never quite sure if they were completely empty. We therefore wanted to create a whole wall of these canisters, but at the time did not have the budget to buy a larger sheet of Perspex to create this.

As part of a themed event, the park celebrated a month of enrichment, with different items being showcased for the public every day. This gave us some budget to work with. The downside of the prototype device was that all the mesh was toward the back of the enclosure, and therefore the public did not really get an opportunity to see this great behavior going on. With this in mind, we redesigned the device, incorporating the large windows set into a sill at the front of the indoor house. Polycarbonate was used as a stronger alternative to Perspex and was ordered to a size that filled the length of one window. A strong wooden frame surrounded the sheet, which allowed the device to be securely carabinered onto eyebolts sunk into the windowsill.

Mark Kingston-Jones

View from the visitors' side, watching the anteater use its tongue to extract food.

The result was even better than anticipated. As the female anteater had a baby at the time, she and the male were separated, and the canisters were filled with mashed banana, her favorite. She came straight over to the device and started to extract the food, to the delight of the public watching, just five inches away on the other side of the glass. As the baby anteater was still on her back at the time, the public also got a fantastic view of him, which added to the overall effect of drawing a crowd (video available—see URL in references).

This demonstration had been advertised as a public talk, and we had plenty of people to talk to during the initial 20 minutes that the female spent engaged with the feeder, until she decided to go and explore what else was available. Because the device is attached with carabiners, it can be put up and then removed the next day, meaning it is not used too often and it does not block the public view when not in use. Since the first use, the device continues to be a success. Different food types have been tested to help maintain the animals' interest, but they have never failed to investigate the device whenever it has been presented (SA Pers. Obs.).

We hope that the takeaway from this idea is that if you have a nice enrichment idea that works well, think about how you can tweak it so that its not just you and the animals that get to enjoy it. Public enrichment demonstrations like this can be used to engage the public and help deliver a message about the animal's physiology and behavior. Unfortunately, anteater talks do not always draw the same crowds as some of the larger, better-known animals, but as with a previous article (Jones, Ford, and Hales, 2012), we can change this perception and get people interested in animals they may not be initially drawn to. By adapting these ideas to the benefit of the animals, it may also encourage more investment and open up funding that were not previously available to you! ✧

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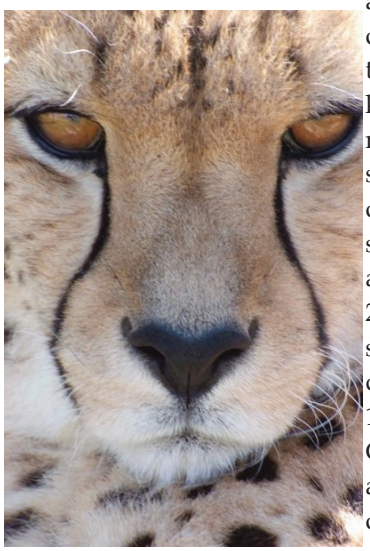
Testing Environmental Enrichment for Captive Cheetahs: A Case Study

By Tessa S. Laurense, University of Utrecht, Faculty of Biology and Animal Ecology, The Netherlands; Deborah Wettlaufer, Cheetah Outreach, Paardevlei, Somerset West, South Africa; Katherine Whitehouse-Tedd, School of Animal, Rural, and Environmental Sciences, Nottingham Trent University, Nottinghamshire, UK; Marie Josè Duchateau, University of Utrecht, The Netherlands

Cheetah Outreach



Cheetah Outreach is a facility housing cheetahs in South Africa that supports conservation initiatives and environmental education as its main goals, where captive cheetahs act as ambassadors for their wild counterparts. However, keeping animals in captivity also means exposing them to potential stressors, some of which may be chronic, such as restricted expression of species-specific behavior and boredom (Morgan & Tromborg, 2007). As a consequence of chronic stress, abnormal behaviors may develop (Wiepkema & Koolhaas, 1993; Carlstead, 1996; Mallapur & Chellam 2002). In order to prevent abnormal behaviors and minimize chronic stress, environmental enrichment can be used to stimulate natural behaviors and therefore enhance the well-being of captive animals (Shepherdson, 1998). In this study we wanted to know whether any of the captive cheetahs displayed stereotypic behavior, such as pacing, as an indicator of chronic stress. Secondly, we tested the effect of five different types of enrichment on the frequency of pacing behavior in the observed cheetahs, to determine the method with the most potential to improve captive cheetah behavioral health.

Cheetah Outreach

Figure 1: Enrichments used in this study. A = Enclosure design; B = Sensory; C = Object; D = Food; E = Exercise.

Observation Methods

For this study, 3 male cheetahs (age 3 to 7 years) were observed twice a day for 30-minute periods, over a total of 79 days. During observations, behavior was scored using a pre-determined ethogram every 30 seconds (Table 1). Behaviors were categorized as vigilance, exploration, inactive, locomotion, grooming, scent-marking, pacing, or enrichment-related behaviors.

Five enrichment methods were tested, with observations for each method divided into three phases: one week of baseline observations without enrichment, one week of observations while being exposed to the enrichment, and one week of post-treatment observations without enrichment. The enrichment methods were used in the following order: enclosure design enrichment (a pile of logs; Figure 1A), sensory enrichment (straw from a female cheetah's sleeping hut; Figure 1B), object enrichment (a plastic Boomer Ball, in combination with horse blood; Figure 1C), food enrichment (frozen horse blood containing pieces of meat; Figure 1D), and exercise enrichment (a whip with a plastic bottle at the end; Figure 1E).

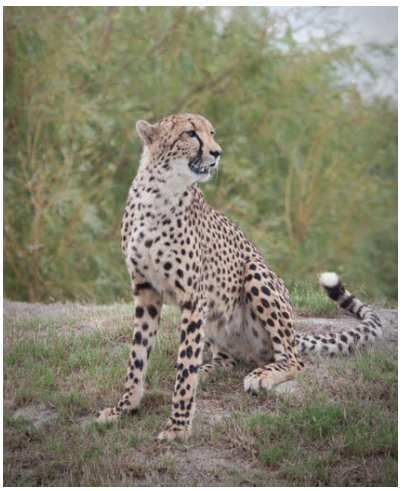
For the eight behavioral categories, the average frequencies per half hour per week were calculated and compared for each enrichment option: baseline vs. enrichment vs. post-treatment by the Friedman test. For all behavioral categories, frequencies were converted into percentages by dividing the number of mean frequency of a certain category by the total scoring numbers per observation (60).

Results and Discussion

Baseline behavior: During baseline observations, cheetahs spent most of their time in inactive behaviors (71-83%), e.g. sleeping and lying down, which seems normal in comparison with the behavior of conspecifics in the wild (Cheeah Outreach, pers. comm.). Captive animals have typically been shown to be less active compared to wild individuals (Gustavsson, 2011), which could partly explain the high level of inactivity observed in the current study. Stereotypic behavior (pacing) was only observed in low frequencies (1-3%) randomly during the baseline period. Since data collection started after feeding, pacing behavior displayed just before feeding was excluded.

Behaviour	Definition	Behavioural category
Sleeping	Lying down with head on the ground, eyes closed	i
Lying down	Lying down with head upright	i
Alert lying	Lying down, head upright, shoulders high while focusing on a specific point	v
Sitting	Posterior on the ground, front legs extended	i
Alert sitting	Rump on the ground, front legs extended, shoulders and head held high while focusing on a specific point	v
Standing	All legs extended, weight divided on all four legs	
Alert standing	All legs extended, weight divided on all four legs, head held high while focusing on a specific point	v
Locomotion	Movement from one location to another at the same height level at any speed	l
Alert locomotion	Movement from one location to another at the same height level at any speed, head held high while focusing on a specific point	v
Leaping (jumping)	Locomotion with four legs, losing contact with substrate	l
Grooming	Licking, chewing or scratching of its own body	g
Climbing	Use feet to propel oneself up or down, without loss of contact with substrate	l
Playing alone	Engaging in playful activities alone	
Rolling	Animal lies on one side and completely rotates to the other side	
Foraging	Searching for edible substances, including sniffing and eating from the ground	ex
Sniffing	Sniffing substrate in enclosure	ex
Licking/gnawing	Oral manipulation of substrate in enclosure	ex
Eating	Eating, licking or chewing edible substances	
Drinking	Drinking of water	
Defecating	Elimination of faeces	sm
Urinating	Elimination of urine without spraying towards an object	
Scent-marking	Animals releases spray from posterior towards an object	sm
Rubbing	Rubbing face or any body part against substrate	sm
Vocalize	Animals makes noise with the mouth	
Social interaction	Engaging in any affiliative or aggressive behaviour with a conspecific, including allo-grooming	
Pacing	Locomotion along the same path with no apparent function that is repeated at least 3 minutes	p
Not visible	All or part of the subject is invisible to the observer	
Specific behaviours regarding enrichment		
Licking/Gnawing	Oral manipulation of object, including mouth carrying	en
Paw	Any manipulation with the paw, including holding the object still	en
Sniffing	Sniffing the object	en
Avoid	The animal walks away from the object	en

Table 1: Ethogram. Gustavsson 2011 & Quirke 2011. Behavioural categories: i = inactive; v = vigilant; l = locomotion; g = grooming; ex = exploration, sm = scent-marking, p = pacing, en = enrichment.



Cheetah Outreach

Effect of enrichments on stereotypic behavior: Numerically, pacing appeared to decrease during the enriched phases of enclosure, object, and food enrichment, compared to baseline and post-enrichment levels. However, no statistically significant differences in pacing frequency were detected between any periods. This is most likely a consequence of the low baseline pacing frequency and the large inter-individual variability detected (Figure 2). With the exception of object and food enrichment, post-enrichment pacing frequency appeared to return to baseline levels (although this was not statistically significant), suggesting that any effect (if present) was only short term. The possibility exists that significant and longer-term effects may have been achieved with object and food enrichment items if a larger sample size had been available, or if animals had exhibited a higher proportion of pacing during baseline observations.

Observations on the Response of Cheetahs to the Enrichment

Enclosure enrichment (pile of logs): Even though the cheetahs seemed interested when the logs were placed inside the enclosure, approaching and sniffing at the logs, they showed hardly any interest after placement. Occasionally they sniffed at them, and only one cheetah manipulated and chewed on the logs.

Sensory enrichment (urine soaked straw): No clear interest was shown by the male subjects in the straw removed from a female's sleeping hut. Just as with the logs, the straw was only sniffed at occasionally. This straw came from an older female's hut and it is possible that she was not reproductively active at the time of the study, so her urine may not have provided any pheromone stimulus to the males. Alternatively, the use of an unrelated male cheetah's urine (potentially even from an external collection to increase novelty) might have elicited a greater response, given the known use of territory marking behavior in free-ranging cheetahs ((Eaton, 1974).

Object enrichment (Boomer Ball and horse blood): During preliminary observations where balls were placed in the enclosure without prior soaking in horse blood, the balls were completely ignored by the cheetahs. However, the use of horse blood on the balls during the study period elicited some response: some of the cheetahs licked the ball for a short time but then ignored the ball.

Food enrichment (frozen blood containing pieces of meat): The frozen blood elicited the biggest observable response in the cheetahs. The cheetahs spent up to 33% of the observation period interacting with the frozen blood. They also showed anticipatory behavior and increased locomotion when the frozen blood was carried towards the enclosure with the enrichment. This suggests that a level of learning occurred during the study, which may have influenced the impact of enrichment methods on the cheetahs' behavior in the current study, since a more randomized enrich-

ment schedule has previously been shown to elicit a great behavioral effect (Quirke & O'Riordan, 2011).

Exercise enrichment (whip with plastic bottle): This enrichment method showed mixed results;

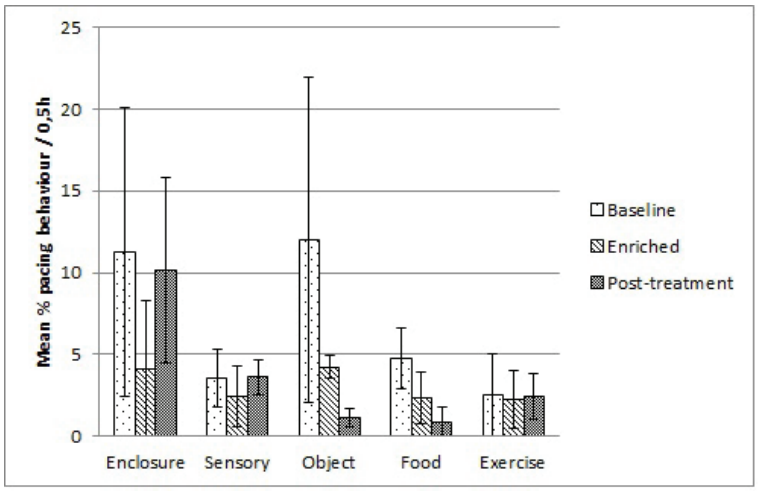


Figure 2: Mean percentage of pacing behaviour during all conditions of each enrichment method. Error bars represent standard error of the mean. There were no significant differences.

one of the subjects always chased the bottle for a few minutes, another subject walked away, trying to avoid this enrichment, while the third cheetah showed interest randomly. Potential influencing factors on the level of interest could be age and weather conditions. Anecdotal evidence suggests that older individuals are less interested in this enrichment method, and that the cheetahs appear less interested during warmer parts of the day. However, based on this study, no statistical evidence for the impact of these potential influences is present.

Cheetah Outreach

Enrichment Recommendation

Despite the low pacing frequency observed prior to the use of enrichment methods in the current study, environmental enrichment is considered to be an important component of captive cheetah husbandry. The use of enrichment has already been shown to have a positive effect, not only on pacing behavior but also on levels of active species-specific behavior (Quirke & O'Riordan, 2011). Therefore, based on this study, we recommend the following enrichment methods for captive cheetahs.

Food enrichment in the form of frozen blood with pieces of meat in it is indicated as having achieved the most interaction and behavioral change in cheetahs. This type of enrichment could be combined with object enrichment to stimulate the cheetahs to engage in activities regarding the provided object.

Although the use of a female cheetah's urine did not provide observable enrichment in the current study, it is suggested that alternative novel scents be tried. Scent is an important part of communication for the cheetah, and therefore enrichment regarding the use of the olfactory system is expected to be effective. Multiple perfumes/colognes have already been shown to generate interest (Thomas *et al.*, 2005).

The use of a lure on the end of a long lead (i.e. whip) had variable effects on the individuals tested here. Therefore, it is recommended to test this enrichment method individually to find out for which cheetahs this form of exercise enrichment works best.

The development of an effective enrichment program for captive cheetahs, and other carnivores, is considered fundamental to promoting optimal behavioral health, but requires testing on a case-by-case basis, and continual review in order to achieve the most effective results in all individuals. ✧

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Husbandry Training for Ring-tailed Lemurs

By Carin Cloete, Elizabeth Grieb, Emmanuel Pila, National Zoologica Gardens, Pretoria, South Africa

The National Zoological Gardens of South Africa has a lemur island where a bachelor group of males is displayed. It is important to hold onto these males in our collection for breeding purposes and genetic diversity. We had five males on the island, and additional males were to be added to the group. We wanted to train basic husbandry behaviors, such as targeting, stationing, and maneuvering, in order to facilitate the successful introduction of the new group members.

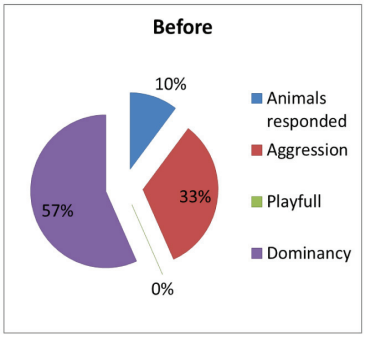
National Zoological Gardens Pretoria

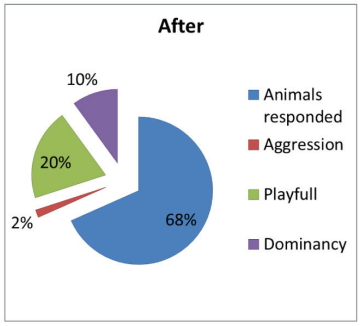
Top: Lemurs on platforms before training began, staying away from keeper. Middle: After training, lemurs interacting with the keepers. Bottom: Lemurs willingly taking food and medicine from keepers.

The ability to reliably move an animal between rooms or exhibit features allows more freedom in preparing introduction situations. The ability to station or target an animal in an area can be used to build tolerance during feeding and allow for other group members to be trained without physically separating all group members. Behaviors that facilitate the inspection of body parts for wound treatment and administration of medications can aid health management. These basic behaviors, once done on command, provide flexibility in management and were the goals of our conditioning program.

A step-by-step conditioning program was started in March 2013. Training with positive reinforcement allows animals to voluntarily participate in sessions aimed at improving care and well-being. In the beginning of the program, the keepers familiarized the animals with the cognitive training methods, and this formed the basis for the husbandry behavior conditioning. After conditioning started, observations showed that dominancy displays between the lemur males decreased almost 40%, aggression decreased 30%, animals responding to the keeper and interacting increased almost 60%, and playfulness increased 20% from almost 0%.

We have found that both the keepers and lemurs are benefiting from the program. The program provides the platform to work from, and more behaviors can be added when the need arises, such as crate training, scale weighing, and close proximity medical treatment and monitoring. The keepers found that the lemurs are easier to manage and are now starting to see the benefit of the conditioning program. It is also easier to check their condition and to treat superficial wounds. In addition, the animals are more visible on the island, and we have created an area for keeper talks during feeding times while keeper interacts with the animals, a benefit to visitors.





The most effective keepers have earned the trust and acceptance of the animals in their care through patience and consistency. It was a challenge to get the keepers and lemurs into the training routine at first, and it took a while for the keepers and lemurs to gain enough confidence to part take in the program. Knowledge and understanding of the natural history of lemurs, as well as the animals' individual histories, was very important. Constant monitoring and observations were also necessary to detect both medical problems and even slight changes in individual behavior or group social dynamics. Through training the husbandry behaviors, the primate keepers optimized their ability to effectively respond to and manage this bachelor group, including the successful introduction of new members. ✧

THE SHAPE OF ENRICHMENT is dedicated to sharing ideas, inspirations, and practical knowledge of enrichment strategies among those working in the field of animal care. It is an open forum for keepers, trainers, curators, researchers, exhibit designers, administrators, volunteers, and anyone else interested in approaches to enrichment. All of our staff are volunteers. We are always looking for new submissions, from feature-length articles to short blurbs. We accept submissions in any form, polished or not. Let us, and your colleagues, hear from you!

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Even if you think your enrichment items, techniques, and projects are typical and have been seen before, you may be surprised—there are many zoos around the world that are always looking for enrichment ideas and options, and what seems "ho-hum" to you may be a revelation to someone else! The Shape of Enrichment was founded on the idea of being an open forum for sharing enrichment, and we're still all about that today. Jump in and share what you've been doing—we want to hear about it, and hear from you!

Nothing formal required—just write about the enrichment you're using, give some pertinent information about the animals it's for and what your goals for the enrichment are, and most of all, how did the animals react and what did they do? Photos of the animals in action and the items/devices/environment are MUCH appreciated, so please email digital images along with your article to shape@enrichment.org. We hope to hear from you SOON!

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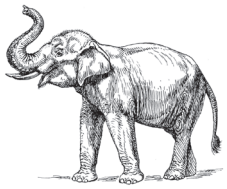

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Features