



species differences

Do you notice a species difference in the readiness with which adult macaques can be matched up as compatible cage companions?



- I have found over the years that cynos can be paired much more easily than rhesus. They seem to be more tolerant, less suspicious when meeting a stranger. Sometimes I form pairs without any preliminary familiarization. I can do this with cynos from time to time without serious consequences, but I would not dare to do it with rhesus.
- Stump-tailed macaques are also easier to pair than rhesus macaques who, in my experience, are more quick-tempered and more readily instigate overt conflict.

SIV-infected animals

Do any of you pair-house SIV-infected [Simian Immunodeficiency Virus] nonhuman primates?

- Whenever possible, we keep nonhuman primates who are experimentally infected with SIV in pairs. The cagemates are assigned to the same experimental groups and receive the same infection and treatment regimen, thus minimizing the effect of cross-infection. The paired partners are also manipulated for treatment and other experimental needs on the same schedule to avoid temporary separation. Multiple experiments involving SIV infections have shown no adverse effects of pair housing. Indeed, stable pairing appears to prolong the life of a macaque with AIDS, presumably due to the support provided by the healthier companion animal (Murphey-Corb, personal communication).



- That's fantastic news! These findings could sway the opinion of those researchers who are still wary of addressing the social needs of SIV-positive animals despite published benefits of pair housing on the animals' behavioral and clinical health [Coe et al., 1982; Line et al., 1990b; Reinhardt, 1990; Eaton et al., 1994; Schapiro & Bushong, 1994; Schapiro et al., 2000; Weed et al., 2003; Steinbacher et al., 2006].



animals with cranial implants

Is it reasonably safe to house monkeys in pairs when they have head caps, eye coils or other appliances?

- It has often been argued that monkeys with cranial implants should not be caged with another companion because of perceived risks of damage of the implant and local infections.
- A colleague and I presented a poster at a National AALAS [American Association for Laboratory Animal Science] meeting regarding our experiences with housing two capuchin monkeys with cranial implants as a pair during a behavioral study (McDonald & Ratajeski, 2005). Neither of the two partners was injured, there was no damage to the implants and we encountered no chamber maintenance issues.
- We pair-house rhesus macaques with cranial implants and have not encountered any problems related to this housing system.
- For at least ten years rhesus macaques with cranial implants have been pair-housed at our facility. We have never had an incident involving an implant mishap or local infection that resulted from social interactions between cagemates.
- After initial resistance, our researchers are now more willing to house their cranial implanted rhesus macaques in pairs. There has been a shift away from thinking that this

is not a possible option. We have worked with many pairs since and have not had any problems associated with the implants.

- We have paired rhesus males with cranial implants for several years. The monkeys tend to show no interest in their mates' implants and we have encountered no implant complications due to housing the animals in pairs.
- I have worked with a large number of pair-housed juvenile and adult female rhesus macaques assigned to neurophysiological studies requiring cranial implants. In the course of more than nine years, no report was made of partners damaging each other's implants or partners causing local infections when meticulously grooming each other's implantation margins. Yes, it is true, the principal investigator initially showed very strong resistance to the idea of having her head cap-implanted animals pair-housed. She finally became an ardent advocate of pair housing after having noticed for herself that her animals—especially the very young ones—were much more robust and able to withstand the challenge of the experiments when they had a companion.
- We keep our cranial implanted squirrel monkeys in social settings and encounter no specific problems.

- Many IACUCs accept the perceived risks as a legitimate excuse for single housing monkeys with cranial implants. While these risks are not founded in any documented or objective statistics, the burden of proof is left with those of us who successfully pair-house these animals. The more people make the effort to get this kind of info published, hopefully, the more the biomedical industry will be willing to move away from single caging to pair housing monkeys with cranial implants.

census

What is the prevailing caging arrangement for macaques, single or social?

- Six LAREF members responded to this question. They assessed the housing status of approximately 4,056 cynomolgus and rhesus macaques and found the following:
 - 70 percent (2,828) of the animals lived alone, while only
 - 30 percent (1,228) of the animals shared a cage with one or two companions.
- Baker et al. (2007) surveyed the housing status of 13,966 cynomolgus and rhesus macaques in 2003 and also found a prevalence of animals living alone without another companion (7,636 animals = 55 percent).

social housing of cynomolgus macaques



group formation

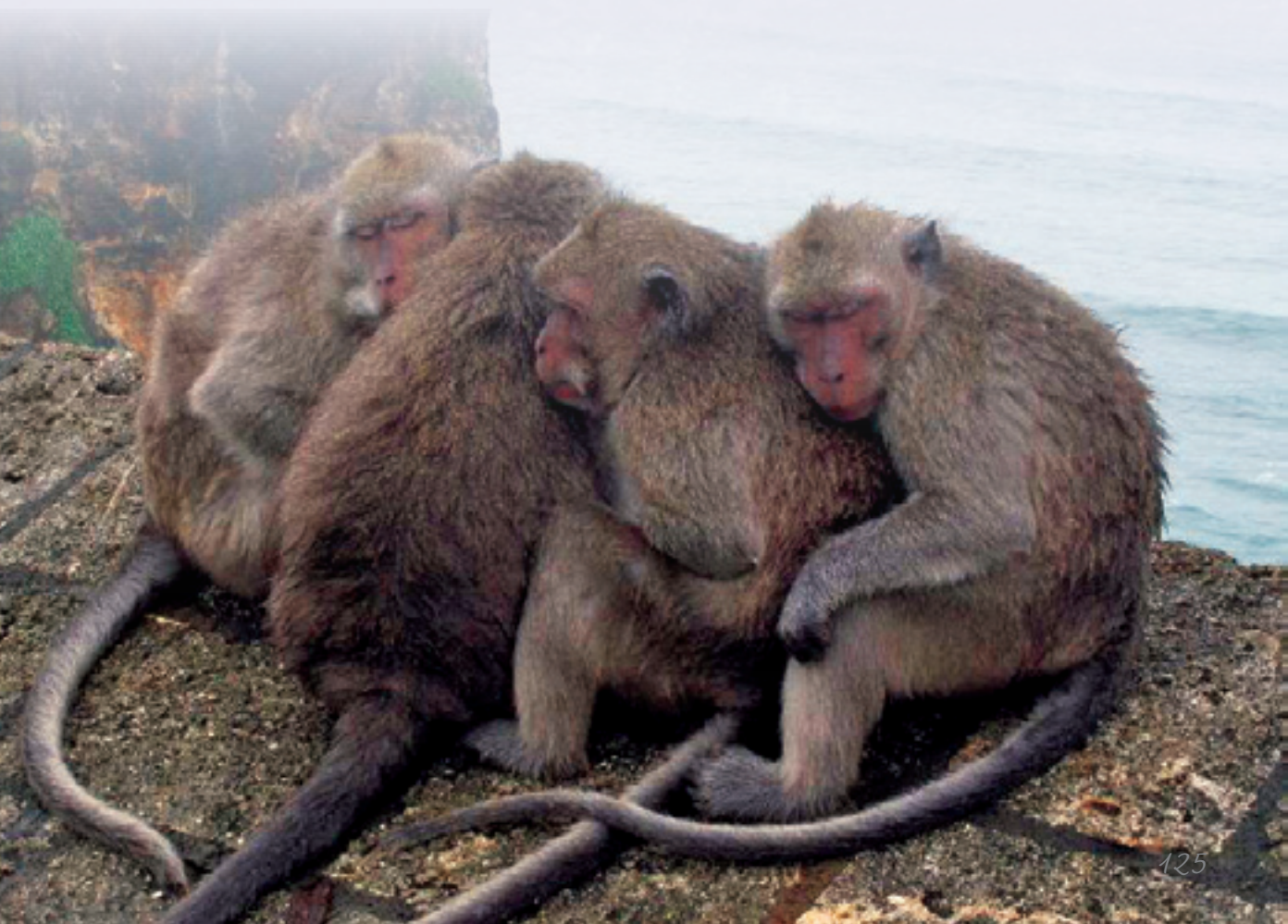
*How do you establish a
new group of cynos?*

- Working with adult males, we first establish several compatible pairs, then a group of four and add pairs to this nucleus until there are 8-10 cynos per group. Each group is kept in a separate room and the appearance, appetite and body weight of each individual is monitored daily to make sure that the animals are compatible. This system works fine at our institution and we encounter no serious aggression-related problems with it.

- Asvestas & Reininger (1999) used a similar approach. They formed 12 compatible pairs of adult males and then brought all 24 animals, who had first been sedated with ketamine, into a new home enclosure where they regained consciousness and established a compatible group.
- Hartner et al. (2001) also started with compatible pairs. Five subadults were first paired with one another in all possible dyadic combinations and subsequently introduced as a group. No serious injuries occurred; the males transitioned through puberty and subadult stages and remained a compatible group as adults.
- Clarke et al. (1995) arranged the single cages of three adult males in such a way that the animals could have close visual contact with each other. After the animals were well familiarized in this manner, they were released into a new home cage. The trio established dominance-subordination relationships mainly via submissive behaviors; no injurious fighting occurred. Relationships were primarily affiliative and the group lived peacefully together for more than two years.
- The best method I have found to establish a new group is to release all animals simultaneously into an unfamiliar pen. This puts them all on equal footing when figuring out the hierarchy and alliances. The most crucial detail for success seems to be visual barriers of some sort. You need to provide the option of visual escape for your subordinate animals. I use simple blinds behind which individual animals can hide, or open-ended tubes into which they can escape.

I would like to caution on grouping adult female cynos. In my experience, they have been some of the most difficult, violent animals I have ever dealt with. Initially, new group members may get along just fine, but then it is like a switch is flipped and the fighting begins. I would rather socialize adult males with intact canines than adult females. We have had so many problems with the females that we stopped socializing them in groups altogether. We do successfully establish small groups of juvenile females. They usually get along well with each other for one or two years before they become adults.

- In the laboratory adult female cynos often don't get along with each other in a group setting, but they readily match up as compatible pairs. I have had a lot of success pairing them; so if grouping them doesn't work out, all hope is not lost to socialize them. I once grouped 14 adult female cynos. This resulted in disaster after about a month and the group had to be disbanded. However, I was able to pair all 14 animals; each of the seven pairs turned out to be compatible and they remained compatible for a very long time.
- In their natural habitat, cynomolgus females are affectionate animals, but they have difficulties adjusting to enforced confinement conditions where they can become rather intolerant of one another.





group housing of males

How safe is it to keep adult male cynomolgus macaques in groups of three or more animals on a long-term basis?

- We keep our cyno males in small groups of up to six animals in male-only rooms without contact with females. These groups typically remain compatible for many, many years. We had groups who remained compatible for more than eight years. Problems may occasionally occur when individual group members are removed for research-related reasons and are no longer accepted by their group when they return.
- That some of your cyno male groups do remain compatible for eight years and longer is remarkable—unthinkable with rhesus males!
- Yes, we are also proud that we can keep the males together in compatible groups for so many years. Visitors are often surprised when they see our mature cynos sharing the same enclosure harmoniously. Our attending care personnel can take credit for this!

animals assigned to regulatory toxicology studies

Cynomolgus macaques have traditionally been single-caged when they were assigned to regulatory toxicology studies.

I wonder, have new regulations and new published findings changed this situation over time?

- All cynomolgus macaques at my facility are pair-housed whenever possible. Pairs on tox studies are separated every day in the early morning for feeding, and put back together in the early afternoon after the food intake assessment for the day. Occasionally a tox study will have only one partner of a pair on study.
- Kelly (2008) illustrated in a recent article the implementation of group housing for cynos assigned to regulatory toxicology studies as standard accommodation at a contract research organization over the last ten years. The only occasion animals are temporarily housed individually is for collection of urine samples for a period of up to four hours. It turned out that study outcomes are positively impacted by the social housing arrangement of the macaques.



kindergarten

What do you do with weaned macaque infants, especially surplus infants from breeding troops?



- It is my experience that an optimal environment for these infants is a kindergarten in which one adult animal keeps order. The kids stay in these kindergartens—spacious, well-structured pens/rooms—until they are almost prepubertal; they are then transferred to compatible pair housing arrangements.

I have established several kindergartens. Follow-up observations over a period of ten years have shown that the youngsters develop very well and that the adult supervisor does, indeed, keep order.

- I used to do something similar when we weaned our rhesus and cyno infants. They went into a pen with a big brother or big sister to *teach them how to be adults*. These were mixed-sex groups; as soon as we began to see sexual swellings and/or any overt aggression, we split the groups into same-sex cohorts or into new breeding groups.



Before we got the idea of making use of aunts or uncles, we saw a lot of fighting between the kids. These prematurely weaned infants were extremely disturbed; idiopathic diarrhea was a constant problem. In their despair, some kids were clinging to one another pretty much all the time, even trying to walk while not letting loose from one another.

The kids started clinging to one another much less often once we added an adult animal to their group. The trick was finding good aunts or uncles for the kids. We ended up with a few who we re-used every year at weaning time. These adults were very tolerant of the kids but also taught them boundaries. When all of the kids were just weaned and missed the comforting presence of their moms, the aunts/uncles would allow them to cling to them; one very

tolerant male cyno even let the kids steal food from his cheek pouch. As time went on the adults became less lenient, but were still very tolerant of the young ones.

The kindergartens were a great way to socially house some of our older rhesus males who were retired from research but lived alone. Each of them adjusted very well to having a whole army of kids groom them—imagine one big male rhesus being groomed by five or six weanlings!

When we had aunts in the groups, we had to be careful and remove the older boys when they began to squabble over mounting their aunt when she was receptive. What is interesting is that we never saw the reverse, which means the uncles usually ignored the older girls in groups, even the ones who had begun to cycle. I figured the uncles knew it was a waste of time, as the girls were still too young to get pregnant. But who knows, they could have just been more careful and not done anything while I was around.



- In the kindergartens I took care of, I often observed youngsters—not only females but also males—cradling and carrying new infants as if they were their moms.
- I had also observed aunts and uncles carrying the kids around.
- I have fond memories of a rhesus named Grandpa, a former alpha breeder who, sadly, lost his sight in his advanced age and was no longer able to breed in a harem setting. Because everyone loved him, and he had had several youngsters in his troop, our lab manager took it upon herself to see if Grandpa could be used for the weanlings. As it turned out, he was fabulous with them! After the height of breeding season, he would receive up to ten weanlings

at a time and did a marvelous job with them. Not only would he allow them to be kids—jump on him, grab his ears and play with his tail—but he would also break up all kinds of disagreements, teach the little ones not to fight over food, and to wait their turn when the treats came around. It amazed us that, even without his sight, he was so wonderful with them. Every so often we would find everyone tucked away in a snuggle patch for an afternoon snooze; and once the little guys started to grow, we would always find them practicing their grooming skills on Grandpa.



foraging enrichment



foraging enrichment with standard food

*Do any of you present the ordinary
standard food to your animals
in a way that promotes
foraging activities?*

- Foraging enrichment for monkeys often implies the provision of special food presented in foraging gadgets. It would be less labor intensive and less expensive to make the animals work, i.e. forage, for their standard food ration.
- I have tried using commercial 3-inch PVC [polyvinyl chloride] feeder cup puzzles for the daily chow ration. It didn't work out well with our rhesus macaques. The care staff wasn't able to see if the chow was eaten at each meal, so they would have to remove the puzzle and check the

contents of the cups. Some monkeys made it difficult to load the cups when the puzzle was attached to the caging. You know how that is—it's either great fun to help or they don't want you taking their possessions. Also, some of our large males had difficulty getting their arms far enough through the mesh to properly manipulate the cups and retrieve biscuits.

Next, I tried using clear shoebox plastic containers. I cut a hole in the top of the container for loading the chow and attached the box vertically with cable ties to the outside cage front. The monkey now has to work each piece of chow through the cage mesh. Since the feeder is transparent, care staff can easily see how much chow has been eaten. Unfortunately, we have to remove these containers for cage wash and some animals do manage to break the cable ties.

- To make our permanently attached, stainless steel food boxes more puzzle-like, we simply added a bar in the access opening to make it more challenging for the monkeys to remove the chow.
- Murchison (1995) had a very similar idea when he modified the standard feeders by replacing the big access hole with several small holes. The time single-caged

pig-tailed macaques spent retrieving the daily biscuit ration increased and the number of biscuits falling on the cage floor decreased significantly when the food was distributed in the modified feeders versus the standard feeders.

- In a previous facility, we distributed the regular food rations of cynos on the top of the cage and have the animals manipulate the food through the bars; we also moved





the food hopper a short distance away from the feeding hole and made the animals work for their biscuits that way. Most of my monks seemed to prefer to work for the ration, even though they had biscuits in easy access locations.

- I also used the wire mesh ceiling of the cage as a food puzzle for pair-housed rhesus macaques on a routine basis. Retrieving their daily biscuit ration through the mesh rather than collecting it from ordinary food boxes resulted in a 80- to 290-fold increase in foraging time. Making the animals work for the daily food

ration did not jeopardize their general health status as reflected in body weight maintenance (Reinhardt, 1993a).

- Our upper-row caged macaques receive their daily biscuit rations in stainless steel boxes attached to the ceilings of their cages; this allows the monks to manipulate and pull biscuits through the mesh, while the box prevents biscuits from being pushed over the edges of the cage. Unfortunately, the box does not fit on the ceiling of the lower-row caged monkeys.
- A very similar system has been described by Bertrand et al. (1999) who found that single-caged rhesus macaques spent approximately 80 minutes retrieving their daily biscuit ration from foraging boxes fitted on the ceiling of their cages. Presenting the biscuits in this manner did not affect the animals' body weight.
- You may want to consider mounting the steel boxes right on to the front mesh wall rather than on the ceiling of the cage. I did this with the ordinary food boxes of several hundred rhesus and stump-tailed macaques and found that this little modification—moving the food box away from the big access hole—gives the animals a chance to spend some time foraging for the daily biscuit ration rather

than simply collecting them from the food boxes (Reinhardt, 1993b,c). In fact, they will prefer working for most of their daily ration rather than collecting all their biscuits without effort from an open box or from the floor (O'Connor & Reinhardt, 1994; Reinhardt, 1994b).

When you mount the food box on the front mesh panel of the cages, the animals will not create a mess. They will work for the biscuits and actually eat them rather than drop some of them on the on the feces-contaminated cage floor (Reinhardt & Garza-Schmidt, 2000).



- Bertrand et al. (1999) noticed that single-caged rhesus macaques spent about 60 minutes foraging when their daily biscuit ration was distributed in boxes mounted over the mesh front walls of their cages. The amount of food wasted was 17 times lower when the animals had to work for their food than when they could collect it from traditional, freely accessible food boxes.
- We throw the daily chow ration of our group-housed rhesus macaques on top of the wire mesh ceiling of their enclosures. The enclosures are nine feet tall, which means the primates must climb to the top to access the chow and manipulate it through the mesh.

Do your animals push many of the biscuits over the edge of the top of the pen, thereby wasting food and creating a mess?

- I can see how that would create trouble, but in my case the pens are actually reinforced with a metal edging, which makes it impossible for the primates to push the chow over the edge. If pieces of chow fall down, they drop to the wood shavings of the pen floor.
- We throw the daily biscuit ration on the large chain-link fence ceilings of our two rhesus breeding troops to promote skillful foraging behaviors. The animals do push some of the biscuits over the edge, but this does not really create a mess. When you throw the biscuits directly on the floor, food wastage is probably much higher because of contamination with fecal material and urine. When the animals have to retrieve their food through the chain-link barrier, they eat it rather than drop it on the floor, so there is hardly any food wastage in the pens.



foraging devices made of cardboard

If we could give caged monkeys simple foraging devices made of cardboard tubes/boxes, we could provide them not only with foraging opportunities but also with entertainment, as they could shred the material. Has anybody tried this?



- When I worked at a zoo, our main method of delivering diets for primates was in cardboard boxes, tubes, egg cartons and anything the animals could tear apart. Tubes were a special hit; we'd stuff shredded paper on top of the food to make the foraging more interesting for the animals. Besides their chow, we would put in frozen mixed veggies, goldfish crackers, chopped fruit, grapes, raisins, nuts and seeds. It was always fun, as a caretaker, to be creative and come up with new ideas. Of course it made the cleaning up at the end of the day more time consuming, but it was worth it.

The trouble in the lab setting is the cleaning up. The enrichment crew and the cleanup crew are different people, so the cleanup crew isn't very willing to clean up the enrichment crew's mess. The main problem seems to be that cardboard pieces



get stuck in the drains. At the zoo, we would hose debris to the drains, leave the drain covers on, and just pick them with tongs and empty them into buckets at the end of the day. But in the lab setting, the drain cover is often removed, so stuff gets down in there and can create clogging problems.

I think a great idea would be to get the cleanup crew involved in giving enrichment so that they could see for themselves that the animals benefit from the enrichment so much that it is worth making an extra effort to clean up the mess.

- We routinely give all of our primates cardboard treat-packs. We stuff large boxes, paper towel and toilet paper rolls with dry treats and crunched-up magazine paper. Our labs regularly save glove and mask boxes for this monkey foraging program.

To make the treat harder to obtain, I sometimes roll the dry treats inside magazine paper and use painter's tape to secure it and then stuff it in the boxes with other crunched-up paper, making the monkeys work their way through a variety of materials to get their treats. Often I spread jam or peanut butter on the magazine paper and sprinkle it with small seeds and nuts before adding them to the boxes.

Cardboard is a huge part of our enrichment program and the primates seem to really enjoy ripping into it, especially large boxes with a variety of treats inside. It is probably not so much the treats that hold the value for the animals but the actual job of ripping open the boxes and magazine paper.

- Your animals are pretty lucky. Obviously, species-adequate environmental enrichment does not necessarily need to be complicated, let alone expensive. A bit of imagination and good will can make a big difference! It is true, some of the enrichment ideas will require some extra work to clean up the mess or—as I have experienced myself many, many times—get the drain pipes unclogged with this darn heavy and long snake. But it is worth the extra effort and time when you see how the animals benefit from your ideas.



- It's true, providing extra enrichment can prove to be time-consuming on the clean-up end of things. We are fortunate in our facility, however, to be able to house all our primates in large pen-like enclosures in which the floor is covered with shavings, and the enrichment, such as shredded cardboard boxes, simply gets scooped out.
- For our cynos we use toilet paper and paper towel rolls for enrichment. They are first autoclaved, then rolled in honey, and afterwards in granola, and finally refrigerated. The monkeys enjoy the extra enrichment and then shred the paper. We have not encountered any problems with this inexpensive enrichment.

- I work with rhesus monkeys and use almost every type of recyclable paper item from home and from the lab, such as cardboard boxes, paper towel rolls, toilet paper rolls, magazines, shredded paper, glove boxes, and surgical mask boxes.

The cardboard boxes get stuffed with dried treats and then taped. The animals seem to enjoy trying to get into the boxes and often, if the boxes are taped firmly, they simply rip enough to get an arm into the box and grab treats. By the end of the day the boxes are torn to shreds!

I often fill the larger boxes with a bunch of loose treats so that, when the most dominant group member gets hold of it, climbs up on a perch and rips the box open, the submissive animals can scramble at the bottom of the pen for the falling treats.

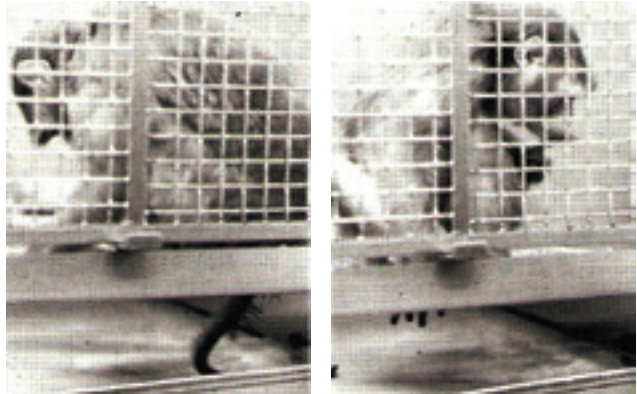
We do not autoclave any of these paper products. Over the years, we have encountered no problems with this kind of inexpensive enrichment.



food scattered on the drop pan

Can you use the cage floor as a kind of food puzzle and have the animals retrieve treats scattered on the drop pan?

- I remember a rhesus male who used his tail to retrieve a liquid food treat from the drop pan. He did this regularly when his aged neighbor spilled some of the daily Ensure™ ration, and this delicious liquid slowly flowed on the surface of the drop pan under the male's cage floor (Reinhardt, 1991b).



- We've had cynos use their tails to scoop up hard-to-reach pieces off the floor several inches below the bottom of the cage, but a rhesus using his tail is impressive!

As a standard for our caged primates, we scatter peanuts, sunflower seeds and cracked corn on the clean woodchips or paper-pelleted bedding of the drop pan at the time of daily cleaning. It

only takes a minute to dump the old bedding into garbage cans and spread new bedding along with foraging mix in each pan.

We don't hose the caging while it is in use, so there is no danger of clogging drains. The cages either have a wide-grid flooring or a small hole cut in the center through which the monkeys reach down to retrieve the foraging mix. This simple arrangement allows for a great deal of time spent sifting through the clean bedding and finding the food.

Since you don't hose cages with animals in them—but rather use bedding—how often do you change cages?

- The cages are completely changed every two weeks; they aren't excessively dirty at that time.

Have you ever considered using the standard food ration rather than treats?

- Yes, we do occasionally distribute the animals' standard food ration onto the clean bedding of the drop pans, but the monkeys take their time eating, so there is always a risk that they continue to forage in the pan when the bedding is soiled.
- Allowing your animals to forage for their biscuit ration in the bedding of the drop pan provides almost ideal foraging enrichment but the hygienic implications are too serious to implement it as a standard operating procedure.

colored food

Commercial food treats for nonhuman primates are usually quite colorful. I am wondering why do we add artificial colors to the treats? If we do it for the benefit of the animals, do they show preferences for specific colors?

- From my personal experience, I believe the animals do have a color preference.
I give our rhesus macaques Fruit Loops cereal as food treats. When I was a kid, I used to eat them with my eyes closed to guess the flavor. I later found out that the Fruit Loops have all one flavor despite their different coloration. When I give monkeys the cereal, some actually do selectively pick out loops of the same color; for instance they would consistently first choose all the loops that are red before taking others of a different color.

- We had a female rhesus macaque who, for a period of more than a year, would only eat green items. She had no interest in food treats unless they were green.
- I have worked with a capuchin who thought all red food was scary; he persistently refused red food treats or simply threw them out of the cage.
- There was a female cyno in my care who loved red things in general, not just food treats. This conspicuous color preference came in handy when I had to administer some of the study compounds; when these were red, she promptly accepted them. When relocating her to a different cage, a red toy made her quickly feel at home in the new cage.



- I did a little experiment with my ten rhesus girls. Over a 22-week period, I presented them five freezies of different colors and recorded which color they chose first. During the first 11 weeks, the five freezie colors were presented once a week strictly in the same order. During the remaining 11 weeks, the five colors were again presented once a week, but now in random order. Two of my girls showed a strong preference for the color purple, that they both chose 91 percent of the time in these 11 trials.
- Barbiers (1985) tested juvenile orangutans and noticed that the animals' consumption of chow biscuits increased when they were colored and that one juvenile had a significant preference for red biscuits over green, blue or orange biscuits.



foraging substrate for new world monkeys



Does anyone have suggestions for a good foraging substrate for New World monkeys?

- We use sani-chips and alfalfa, oat or timothy hay for our squirrel monkeys. We also place treats in the clean bedding when we change the drop pans.
- We place beta-chips, shredded paper and dry oats in the drop pans—right after pan change—and add foraging mix to this substrate for our New World monkeys. The owl and squirrel monkeys really like this, and even the galagos get into foraging from the pans.





- Our group-housed squirrel monkeys have access to high quality hay on which small food items are scattered at least once a day. The animals seem to be fascinated by this natural foraging opportunity of which they do not get tired over time.

popcorn

Does popcorn provide a suitable foraging enrichment option for caged monkeys?



- We air-pop corn several times a week in the rooms of our cynos and distribute the popcorn directly to the animals. The whole process is perhaps a bit time consuming, but the animals' enthusiastic response makes it pay off. They attentively sniff the air and stare at the popping machine when the kernels pop and eagerly first investigate each popcorn they get, then nibble at it, and finally eat it. Popping and distributing popcorn in the animals' room provides great entertainment not only to the animals but also to the attending personnel.
- Our macaques get air-popped corn once a week in their rooms; sometimes it coincides with movie time, but not always. Most of the monks like the popcorn; some don't care much about it. However, all of them like to watch the air popper in action. The squirrel monkeys also get popcorn popped in their rooms and they go crazy for it; I think squirrel monkeys love anything that smells and makes noise. They are not very keen on the popcorn but their response leaves no doubt that they enjoy watching when it is created by this noise-making gadget in their room.



- We have “melted” one air-popper, so we have all learned to unplug/turn off the poppers when you stop hearing it pop, even if it isn’t your responsibility that day.
- I will sometimes get the popcorn popper out for our rhesus macaques on Saturday afternoons and make a big display in the middle the room. They go nuts! My facility manager and care staff will come down to help distribute the popcorn, and it’s a fabulous time for all. Occasionally, I’ll pop extra and then use it during the week by putting a measured amount into a bag or box. I’ll then drizzle a tiny bit of honey over the top and give it all a good shake. It’s low in caloric value. The monkeys have a blast eating the popcorn and then picking or licking the honey off the sides of the paper.

- Wouldn’t it polish the image of our company/facility/laboratory if we shared with the public in animal welfare-oriented magazines or newsletters that we provide our animals quality produce/fruit on a daily basis, that our animals get their favored treats when we visit them, and that we entertain them by popping corn right in front of them, give them mirrors to secretly watch us, and entertain them with videos, if they want? Some of us even take the trouble to spend much time and patience to train the animals in our charge to work with, rather than against us, when we handle them during experimental procedures.
- The public often “knows” through hearsay that we do bad things with the animals in our charge. Why should we not let the public know that we actually do care for the welfare of our animals? It takes some effort to write such stories but it certainly can pay off for everybody involved in the biomedical research process.



fruits and vegetables

What is a reasonable serving size of fruits and/or vegetables for a macaque as part of the environmental enhancement program?



- Each of our adult rhesus macaques gets the equivalent of half an apple or comparable sized fruit and a vegetable, like a stalk of celery or a quarter of a green pepper every day. Immature animals get about half of that daily portion. These supplemental food items do not interfere in any noticeable manner with the animals' normal consumption of their daily biscuit ration.
- We give our group-housed rhesus macaques fresh produce twice a day. Each animal gets at least one piece of fruit or vegetable the size of an apple. We feed a great variety of produce of the season such as apples, oranges, bananas, yams (favorite of all the monkeys!), pumpkin, lychee fruit, grapes, cranberries, lettuce, bok choy, cabbage, lemons, limes, onions, potatoes, garlic, carrots, beans, peas, corn on the cob, peaches, nectarines and apricots.
- Based on species/age/weight, our monkeys receive quarters, halves or whole oranges on a daily basis. In addition we feed them fresh vegetables and fruits based on seasonal availability—such as bok choy, tomatillos, banana leaves, celery, kiwi, lettuce (all varieties), cabbage, kale, mustard greens, herbs, turnips, onions, bell peppers, fresh corn, cucumbers, cauliflower,



broccoli, carrots, pears, melons, apples, bananas and grapes—three times a week. Our animals also get a variety of herbs—such as basil, chives, oregano, rosemary, tarragon, mint and thyme—that we grow ourselves throughout the year.

- We distribute whole fresh fruits and veggies to our rhesus and cynomolgus macaques, in the morning and in the late afternoon, every day.
- Each of our 700 pair- or single-housed rhesus and stump-tailed macaques receives one whole apple, orange or banana each day—including weekends and holidays. Group-housed animals in pens receive daily more whole fruits than there are adults in the group so that low-ranking animals can also get their share.

Rather than wasting time chopping the fruits, our caretakers are encouraged to take their time distributing whole fruits to each caged animal and check the compatibility of groups while distributing the fruits to them.

- Your phrase “caretakers were encouraged to take their time distributing whole fruits to each caged animal” warms my heart. Time is what the staff needs, to establish important bonds with the animals in their charge; this time should always be available. Unfortunately, some facilities regard time as money, so animal care staff is often overworked with too little or no time to spend in *nonproductive* friendly interaction with their animals.
- Our rhesus macaques also receive fruit or veggies twice a day, every day, as a supplement to their standard diet. We give them pretty much anything you can find in the produce department of a grocery store.





When you provide fruit and vegetables to primates on toxicology studies, are there any precautions you need to take?

- Suitable for human consumption is the requirement at our facility. We stick to a standard list of fruits/veggies though; this applies to GLP [Good Laboratory Practices] and non-GLP studies.
- I work at a CRO [Contract Research Organization] with primarily GLP tox studies and the thinking here is that, if the produce has been purchased through an approved vendor—one that sells for human consumption—it is acceptable for the monkeys. Of course, the produce is washed and most of the fruits are peeled as well. Our clients are aware of our guidelines and if there is any concern on their part we will modify our feedings to accommodate the study. As of yet I have not had anyone raise objections to the feeding of fruits or vegetables.

- I have recently found that our monkeys love red beets. They look adorable with the red lipstick; so the only time we don't give them the beets is when we collect urine for a one-week study, as we do not think the investigator would appreciate the purple pee.
- I would certainly have to send out word to all technicians and study directors, if I was to give red beets to our monkeys; red lips, black feces, and purple pee—I would have people going crazy!



- We're also a CRO; about 90 percent of our primate work is GLP. We have an IACUC-approved standard section in all our primate protocols that states: "Certified Primatreats and fruit and food suitable for human consumption are also given as a supplement at least once each day and documented." If clients want to opt out, they must present written scientific justification to the IACUC. In 13 years I've had this questioned only one time and, when told what must be done to opt out, the client said "never mind."



- The majority of our work is GLP and we do supplement feed our monkeys with fruits, vegetables and foraging mix. We have a list of seven fruits and veggies and foraging mix that we can choose from; the amount to offer the monkeys is predetermined. A fruit or veggie is offered on Monday, Wednesday, Friday, and Sunday; foraging mix is offered on the other days. The animals do not receive the same fruit or veggie more than once a week.



- The fruits and veggies are considered fit for human consumption and we do not wash or peel them before giving them to the monkeys. During a study, the technicians document what is given to assigned monkeys every day.

It is rare for an investigator to express concerns about our supplemental food program. The only time that I recall us modifying the amount or kind of food supplement offered during a study was for monkeys who were having GI [gastrointestinal] issues. If an investigator wants his or her animals excluded from the supplemental food program, he or she would have to submit a written explanation to our IACUC and get the committee's approval.

foraging balls

Does anyone bait plastic foraging balls with fresh produce?

- I have used grapes, baby carrots and slices of sweet potato with great success for many of our long-term rhesus and cynos. The grapes are a great motivator, but are relatively easy to retrieve. The slices of sweet potato are harder to manipulate through the little holes, but the monkeys love it anyway!
- Our monks—rhesus and bonnets—seem to like pretty much anything edible we put into the balls, such as all sorts of treats, popcorn, fresh or dried fruits, and vegetables. We sometimes make it more challenging for the animals to retrieve the food items by chopping them into relatively large pieces. One of our fabulous techs had the great idea of attaching the baited balls with a short chain on top of the animals' cages so that they can forage either through the bars of the ceiling or, when the ball rolls over the edge, forage through the bars of the side wall of the cage.
- Frozen red globe grapes are my favorite baits for the foraging balls. The monks have to figure out the one hole through which the big grapes fit, or they wait until the grapes are thawed and then retrievable by squishing them through any hole; either way, it is quite a time consuming process for the monks to get these big grapes.



- I wrap peanuts, dried fruit, and pieces of fresh fruit in paper and stuff this package into the balls. It makes the foraging a bit more challenging for the monkeys, who first have to rip the paper to get to the treats.
- I fill the balls with peanuts in the bottom half with no holes, and shredded paper in the top half. The shredded paper helps prevent the peanuts from falling out and makes it harder for the monkeys to get them.
- Rather than paper, I use hay to stuff the top part of the balls; the bottom part is baited with treats. The rhesus and stump-tailed monkeys spend quite some time fiddling with the hay in order to finally get hold of a peanut, raisin or piece of apple.
- You can easily make inexpensive foraging balls from coconuts that you suspend in the animals' home enclosure. Squirrel monkeys love such natural food puzzles when they are filled with their favored treats. Coconut puzzles are probably not so suitable for larger primates; I am sure macaques would destroy them rather quickly but, on the other hand, to replace them with new ones is not so expensive.



inanimate enrichment objects



toys

How do we know if a monkey likes a toy?

- I don't know if a monkey *likes* a particular toy, but I think a toy fulfills its function if the monkey interacts with it on a regular basis. If the monkey plays with the toy on one or two days and then loses interest in it altogether, then I would say that the toy is not enriching the monkey's environment, maybe because it does not trigger species-typical activities.
- We recently validated the Flexi-Keys™ with juvenile and adult cynos. Some of the animals would manipulate the toy a lot, and finally push it out of the cage through the food hopper and drop it on the floor. Some people could interpret this as the animal not liking the toy.
- I have seen some of our monkeys maneuver all kinds of toys through the feeder, until they drop out of the cage, and then try to reach out to get them back again; it's probably an entertaining game for them.

- We had quite a number of individuals in our rhesus colony who used their biscuits as a toy substitute, and with great perseverance kicked one biscuit after the other out of the food box. Not only that, but the monkeys would attentively look out of the cage and check where the biscuits had landed on the floor. For them, it was all fun, albeit a waste of food.
- Our monkeys seem to love the Flexi-Keys™. We use a chain to attach these to cage fronts, and the monkeys manipulate and chew them through the cage bars more than most other toys attached this way. When we place the keys on the top of the cage, the monkeys will pull individual keys through the bars to have them hang down. They often shake or carry these toys when we place them on the cage floor. Some will push them through the feeder and then try to get them back inside. When they do this maneuver, they sometimes lose their grip and the keys end up on the floor. Others seem to drop the keys on the floor on purpose so that they get the attention of the personnel who will fetch the toy and return it.
- I assume that your monkeys find this little game quite entertaining, especially when the attending person is cooperative and picks up the keys over and over again, to the delight of the critter. Throwing something out of the cage does not necessarily mean that the monkey does not like the object. It's just another way of doing something other than being bored.



- Toddlers do that also: they may throw their favorite toy out of the crib, and they are so happy if you pick it up and return it to them. This can go on for some time until you get tired of it. The child may then try to keep you playing the game by throwing all the toys out of the crib. If nobody comes by to return the toys, the child may get frustrated and cry because the toys are now out of reach.

safety issues

Based on your experience, what specific safety issues have to be taken into consideration when supplying monkeys with enrichment objects?

- When we design and evaluate new enrichment ideas for our animals, we try to make them simple in design, durable and easy to clean. Most of our devices are made from PVC. This material is very durable and can withstand severe treatment from the animals; some of our devices are several years old and still in reasonably good condition. We also do not use small parts that the animals can get loose and possibly swallow. For manipulable enrichment we use solid rubber toys that can be thoroughly sanitized. We replace them before they have been worn/chewed down so much that the animals could swallow them.

- We have used small branches for enrichment with our monkeys and it has been really good for them as natural objects for gnawing.

We did encounter problems when we gave the gnawing sticks to diabetic monkeys; these animals often have a real craving for food and eat everything they can get hold of. We had one diabetic monkey who swallowed so much of the shredded branch material that she bloated and died. Needless to say, we no longer give branch segments to any diabetic monkeys.



- We had a bad outcome when one of our monkeys got strangled by a chain that suspended a toy from the wall of the cage. We now put a short piece of PVC pipe over these chains; this simple modification has made all our chain-suspended toys safeproof.
- A lot of times I purchased dog toys for primates. They have these hollow cubes where you put the treats inside, and dogs roll them around on the ground and eventually a treat falls out. I thought these would be great toys for the monkeys. When we came in one morning, we found one of the girls got her hand stuck in the hole. We had to anesthetize her and cut the cube off her hand. Her hand was pretty swollen, but she recovered completely. All those toys went straight into the garbage after this incident!
- Monkeys can be extremely inquisitive and possessive. I remember a young rhesus male of a breeding troop who managed to get hold of a padlock that was not properly locked. The top ranking male immediately stole the trophy, examined it, and being encircled by many curious monkey faces, stuffed the padlock into his mouth and pushed it right into a cheek pouch! When he was alone, he wanted to retrieve this hard and edgy, apparently not edible thing but didn't succeed. He tried very hard—perhaps even regretting his hasty mistake!—but failed. After a half-hour, I had no choice but to catch the fellow, give him a ketamine injection and carefully remove the large padlock from the small cheek pouch. The lesson I learned from this incident was, not to give the animals play things that are small enough to fit into a cheek pouch.





mirrors

Based on your own experience, do you find mirrors useful enrichment devices for monkeys?

- The cages of our baboons are each furnished with a mirror. The animals do not seem to lose interest in their mirrors but use them with consistency to kind of secretly observe people and activity going on in the room without directly looking at people.



- We use round stainless steel mirrors for rhesus, baboons and vervets. They are hung on the outside of the cages. The animals use them very frequently to see other animals who are not in their field of vision, as well as people who are entering the room. Some monkeys prefer to manipulate the mirror while others constantly hold it up to their face as they look around the room and appear fascinated by the multitude of reflections they see.

Since the animals' interest in their mirrors decreases over time, we give them access to the mirrors not permanently but always only for a few days on a rotating basis.



- I cut rectangular mirrors from clear, mirrored acrylic sheets for our rhesus macaques, and either hand them directly to the animals or suspend them with zip ties from the cage tops. The monkeys seem to prefer their *own* mirror that they can carry around and use to look at us without having to make direct eye contact. I work with my primates daily and see them using the mirrors with great consistency. They do not seem to lose interest in their mirrors but handle them more often than any other enrichment device we have at our facility.



- For our cynos, we use three different mirrors: two disposable polycarbonate types, one rectangular (76 x 127 mm/3 x 5 in) and the other circular (152 mm/6 in diameter). The third type is two-sided enclosed in a frame (102 x 152 mm/4 x 6 in). We attach the mirrors outside to the front panel of the cage, and rotate them often to avoid habituation. The animals can manipulate the mirror, changing its angle and pulling it into their cage an inch or two.

When the mirror is placed on the cage, the monkeys typically respond to it as if they were encountering another monkey by displaying dominant or subordinate gestures toward the mirror reflection. This interaction takes about five minutes before they simmer down and start manipulating the mirror and changing the angle in order to see other reflections.

- Our cynos mainly use the mirrors to watch us while we are in the room. Some of them like to watch themselves in the mirror and will lip smack or study their reflection. They use the mirrors far more often and for longer periods of time than any other, also frequently rotated, enrichment device.

The mirrors are particularly useful for adult feral males, who take little notice of other enrichment gadgets.

- I use 3-inch stainless steel mirrors for my marmosets; initially they seem to like them. When I leave the mirrors attached to the cage all the time, most marmosets give the impression of getting a bit bored, but some will sit in front of their mirrors for hours, obviously really enjoying them. Once, I handed a small plastic-backed mirror to one animal who picked it up, then moved from one side to the other, back and forth, as if to look for the other members of the group—very cute!

television and videos

We have been using television for visual enrichment of our macaques for years. I was wondering what you all do at your facilities for visual stimuli for your animals?



- Our capuchins can watch TV in the afternoon and on the weekends. We train them to help disabled people, so we actually teach them how to use a regular TV. They use the buttons on the front of the TV; they can go up or down the dial until we either ask them to stop (training) or they find something they like (free time). It appears to me that the animals like some programs more than others. These animals are smart and need something to at least think about. I figure it is like being at car repair garages: all have a TV to amuse us while we wait.
- We have a TV that rotates through the rooms; it really seems to be great for the animals in restraint chairs, even if they just listen to the sounds. Our chair-restrained macaques are always with others whom they know very well; there are four animals per study group and we place the TV in such a way that each animal can watch the screen. Generally our animal rooms get between one and two hours of TV per week; sometimes monkeys get popcorn along with their movie.
- TV time is written into our Enrichment SOP [Standard Operating Procedure]. Each primate room will receive a minimum of one hour per week of undisturbed TV time. We are in the process of exchanging all cartoons with primate videos.