IN TOUCH

For the humane use and care of laboratory primates

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Our Mission

A new approach to research with non-human primates is evolving in laboratories around the world. The change is not in response to governmental regulations, company SOPs, or threats from animal rights advocates. More and more, researchers are taking a second look at their research subjects. Instead of a lab number or a point on a chart, they are seeing curious, thinking animals that feel pain and pleasure, require the nurturing of their mothers as infants, seek out social interaction with companions, and require often-complex activities to stimulate their minds throughout the day. Indeed, the researchers are looking into the eyes of human's closest relatives.

The simalarities between humans and other primates is well documented, and is the prime reason they are used in human health studies. A new league of researchers recognizes this irony, and instead of battling with animal advocates over the ethical issues of animals in research, they are working within the established scientific community to provide enriching, fulfilling environments and humane treatment for the subjects in their care. Your interest in this publication places you in that league.

The mission of IN TOUCH is to continue this evolution by providing you with practical

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In This Issue

An Enriching Approach to Captive Chimpanzee Care

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Although we need positive information on how to promote primate well-being, what past research has given us is mostly negative information—about the lack of well-being. Most of this negative information was gathered in deprivation experiments (Davenport and Menzel, 1963; Davenport, Menzel, and Rogers, 1966; Davenport and Rogers, 1968; 1970; Davenport, Rogers, and Rumbaugh, 1973; Menzel, 1963; 1964; Menzel, Davenport, and Rogers, 1963a, 1963b; 1970; Harlow, 1962; 1964; Harlow and Harlow, 1962; 1965; 1969; Evans, 1967; Elias and Samonds, 1973). These studies tell us what to avoid in housing captive primates, yet only implicitly suggest what might be beneficial. For example, we know that isolation is deleterious, but not which types of social housing are optimal. Too often, the selection of positive procedures and conditions conducive to psychological well-being are left to the educated guesses of individual researchers. Line (1987) makes this point in regard to cage size: "Standards concerning the amount of living space required for laboratory animals are controversial and generally are based on experience and professional judgment rather than objective considerations" (p. 857).

Science and humane treatment need not oppose each other, in fact they should complement one another. The needs of the animal subject and the needs of science can be fulfilled simultaneously. This article focuses on space requirements, the benefits of play and exercise, and social and environmental enrichment for the chimpanzee. But first we will very briefly review some of the behavioral damage that isolation can do to primates.

Deleterious Effects of Isolation and Deprivation

Davenport (1979) found that chimpanzees reared in socially and environmentally deprived conditions exhibited many behavioral abnormalities and problems not exhibited by chimpanzees reared by their mothers or by humans in a nursery. The deprived chimpanzees typically developed

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Photo by April Otley.

Tatu sits on a treatmound licking a stick, which is used to retrieve the treats.

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stereotypies such as rocking, head banging, and so on. Rearing in a restrictive environment for 2 to 2.5 years produced enduring deleterious effects. Several years after the deprivation conditions had ended some chimpanzees were still showing intellectual deficits. He states that "The persistence of cognitive deficits in the restricted-reared chimpanzees, even after 12 years of environmental enrichment, prolonged testing, and group maintenance, is interpreted to mean that deficits so acquired are not readily corrected" (p. 351). Davenport also noted other long-term behavioral dysfunctions produced by deprivation. Female chimpanzees reared in restricted environments did not show appropriate maternal behavior as adults, and reproductive behavior in adult male chimpanzees was also disrupted. There were deficits in other kinds of social behavior as well. Restricted chimpanzees were either unresponsive or responded inappropriately to social stimuli for the first few years after their isolation. In summary, restrictive environments deprive chimpanzees of the necessary sustenance for healthy intellectual, maternal, sexual, and social development.

As we said earlier, in addition to psychological damage, restrictive conditions have the potential to produce neurophysiological damage (Finger and Stein, 1982), and this, indeed, may underlie the behavioral, intellectual, maternal, and social dysfunctions evidenced by the chimpanzees studies by Davenport (1979).

Comparable deleterious effects of isolation have been demonstrated in other primates, including rhesus macaques (Harlow 1962; 1964; Harlow and Harlow, 1965, 1969), pigtailed macaques (Evans, 1967), bonnet macaques (Rosenblum and Smiley, 1984), and cebus monkeys (Elias and Samonds, 1973). These effects are like those reported by Spitz (1946) in his famous study of human children raised with minimal social stimulation in an orphanage. There are, of course, species as well as individual differences in the effects of deprivation (Barnett, 1981, p. 411-412). For example, Sackett et al. (1976) found that complete social isolation affected rhesus (*Macaca mulatta*) and pigtail (*Macaca nemestrina)* monkeys very differently. The rhesus monkeys rocked, hit and bit themselves, clutched themselves, and failed to explore their environment, while the pigtail monkeys showed no such abnormalities. An important lesson for primate well-being is that we need specific information on optimal conditions for each primate species held in captivity or studied in the research laboratory.

Cage Size and Space Requirements

Cage size is an important variable for the psychological well-being of chimpanzees. Some people have treated it as if it were a new topic with no history. Research exists in the literature, however, with implications for cage size that has been available for quite some time. For example, twelve years ago Clarke, Juno and Maple (1982) examined the behavior of three chimpanzees who were moved from a laboratory cage 8 X 20 feet in size (more than seven times greater than the old minimal regulations and nearly so for the new) to an island that was 40 X 120 feet in size. Two weeks prior to the move to the island, the male had a mean hourly stereotypy rate of 26.5 for week one and 45.75 for week two. Once on the island, this hourly rate of sterotypies dropped to 8.5 the first week and ranged between 0 and 4.0 for the following 21 weeks. In a similar study, Pfeiffer and Koebner (1978) examined the stereotypy rate in eight chimpanzees who were moved from a laboratory to an island. The two chimpanzees with the highest rates before the move were found to have decreased their stereotypic behavior by 70% six months after the move to the island.

We should be looking for captive enclosures that have outdoor access or at least simulate the complexity and expansiveness of the outdoors.

Another study conducted 30 years ago has an interesting history. It has been referenced as indicating that stereotypical behaviors are not related to cage size (Line, 1987). However, when the study is examined, with all experimental conditions taken into consideration, a different picture emerges. Berkson, Mason, and Saxon (1963) experimented with varied enclosures and measured the rate of stereotypies in the chimpanzees who had experienced early deprivation in a study done by Davenport and Menzel (1963). Berkson et al. began their experiment after the chimpanzees had been living in the standard laboratory environment at Yerkes for approximately three years. Berkson et al. found that when the chimpanzees were placed in a wooden isolation cage measuring 81" X 59"X 78" (33.2 sq. ft.) that was occluded so that they could not see out, they engaged in stereotypies 85% of the time. When the chimpanzees were moved to an outdoor cage with bars allowing them to see out and only slightly larger, 69" X 72" X 85" (34.5 sq. ft.), their stereotypies dropped down to 52%. Their lowest stereotypy rate of 15%, however, occurred when the chimpanzees were placed with other chimpanzees in an outdoor enclosure measuring 39 feet by 57 feet (2223 sq. ft.)

Berkson et al. continued the study by investigating the effects of giving objects to isolated chimpanzees, as well as the effects of a third even smaller cage measuring 60" X 33" X 32" (13.75 sq. ft.) that had three sides occluded and one side open so the chimpanzee could see out. Berkson et al. reported that, while in this new small cage, the chimpanzees engaged in stereotypies 34% of the time when they had objects to manipulate and 36% of the time when they did not. These results were compared to the larger completely occluded wooden cubicle where the chimpanzees stereotypies took up 59% of their time when they had objects to manipulate as compared to 67% of their time when they had nothing. Because the rates were lower in the smaller cage (34% and 36%) the researchers concluded that cage size alone does not necessarily affect the incidence of stereotypies. However, it should be pointed out that any potential positive effect related to cage size alone may have been canceled out by the total isolation produced by the cubicle.

When these results are compared to the results in Experiment I, another conclusion can be drawn. Namely, that cages of the size tested here may have all been too small and that the increases did not make much of a difference. However, when there was a dramatic increase in cage size (e.g., from 33.2 sq. ft. to 2223 sq. ft.) with the outdoor cage and by placing the chimpanzees in a social group, there was a dramatic improvement in their behavior. We interpret these results to mean that a linear relationship between cage size and psychological well-being in terms of reducing stereotypical behavior or aggression may be incorrect. It appears that cages smaller than 200 sq. ft. have a nonlinear relation that can be effected by

external conditions such as ability to see out or having objects to manipulate. The largest effect seems to occur when the animals were allowed to have a large outdoor area. This is consistent with the Clarke et al. and the Pfeiffer and Koebner studies.

In addition to cage size there are other critical variables that affect psychological well-being. Wilson (1982) examined activity levels of gorillas and orangutans in 41 zoos in relation to seven environmental factors: size of the enclosure, useable space, frequency of feeding, number of animals, and the number of objects (stationary, temporary, and moveable). Contrary to what was expected, size of enclosure, useable surface area, and frequency of feeding were not related to activity level. Instead, high activity levels were related to increased numbers of animals in the enclosures and many movable and/or temporary objects. A study by Traylor-Holzer and Fritz (1985) also confirms the need for a complex environment. It was found that adult chimpanzees used upper cage levels, cage permitters, and small areas more often than open cage areas. Juveniles, on the other hand, tended to use all available space evenly. The authors concluded: "The incorporation of vertical structures, visual barriers, and multiple small areas to create complexity in captive chimpanzee housing is often practical and may aid in creating an environment more conducive to normal social interaction" (p. 126).

Van Hoof (1976) describes a chimpanzee colony in which the chimpanzees spent most of the day close to the building although there were 25 acres to roam in. In all this space, the only shade was next to the building, and activities such as feeding occurred in the same area. The chimpanzees remained clustered in this area, and the level of aggression was high. If shade and feeding stations had been spread out, the useable space would have increased, the chimpanzees would have spread out and aggression surely would have decreased. This is further evidence of the need for a complex environment, not simply a larger space. The consistent message for all of these studies is that we should be looking for captive enclosures that have outdoor access or at least simulate the complexity and expansiveness of the outdoors.

Design of Habitat

Wild chimpanzees range over large areas, both on the ground and in trees (Goodall 1986). In May, 1993, we moved our group of five chimpanzees to a new facility. In our old facility, which had four enclosures in four separate rooms connected by an overhead tunnel system on the floor, we tried to recreate some of this diversity. Wild chimpanzees are social, yet at times travel alone, so our design gave the chimpanzees their choice of being social or alone. It provided opportunities to avoid contact (visual as well as physical) when desired by going to another room. Benches in each room added more diversity and increased usable space. The chimpanzees nest in the overhead tunnels at night. Other researchers hold that such escape outlets, privacy refuges and visual barriers that allow the animals to avoid contact, help to control aggression, and social stress (van Hoof 1973; Maple 1978; Maple and Stine 1982; Fritz and Nash 1983; and Traylor-Holtzer and Fritz 1985). Chimpanzee housing must be large enough and varied enough to encourage social interaction but also allow for privacy.

In our new facility, we recreated the beneficial aspects of the old facility. In its design we included benches, overhead tunnels, varied rooms, and caves. We also added new beneficial features. Fencing was used to increase the usable surface. For example, a mesh fabric covers the outside area so the chimps can use it to climb above the ground as high as 32 ft. In the areas where there are concrete walls, rungs were installed or hoses hung nearby so that vertical area could also be used. Complexity was further increased with varied level terraces, hanging cargo nets, swinging tires, poles, climbing structures, and vegetation such as grass and bamboo.

In research from our laboratory involving 899 one-minute observation periods, we have noted preference for areas as a function of the activity. Fifty-seven percent of the play-and-chase games took place in rooms 3 and 4 (a total of 70 sq. ft.) and another 14% in the floor tunnel connecting these rooms. The overhead tunnel to room 2, and room 2 itself, accounted for 29% of play. Rooms 1 and 3 were the preferred rooms for affinitive social behavior (67%) and mutual grooming (60%). We also found individual differences among the five chimpanzees. Moja took her food to room 4 to eat 92% of the time, Dar always ate in the floor tunnel between rooms 3 & 4, whereas Loulis ate in rooms 1 (23%), 2 (15%), 3 (39%) and the tunnel between rooms 2 and 3 (23%). As for grooming, Moja groomed only in room 1, while 91% of Loulis' mutual grooming occurred in room 3. Moja played only in room 3. All the chimpanzees preferred the tunnels for sleeping at night, resting during the day, and observing the humans in the laboratory. The diversity of design allows these chimpanzees to use their environments fully in a wide variety of different activities.

The social environment is perhaps the most critical factor in chimpanzee well-being, more important even than design of the living space.

Exercise and Social Interaction

Critical to the psychological well-being of primates is the opportunity to exercise and to interact socially. One form of social interaction that has been studied extensively is play. Although adults as well as young primates play, playing has been studied mostly in the young, where it has an important role in psychological and neurophysiological development. Mason (1965) found that chimpanzees spend 70% of their time playing and have as many as 16 times more social contacts than adults, the majority of which are play interactions. Harlow and Harlow (1962) found that peer play was important in the development of young rhesus; it promoted social development and helped compensate for maternal deprivation. In human children, play has been found to be critical in cognitive development, especially of creativity and divergent thinking (Lieberman 1965), and it facilitates problem-solving in children (Rosen 1974). In short, to develop properly, primates need to be housed in species-typical groups and to have the opportunity to play with conspecifics during exercise periods.

Signs of Enrichment

We have already discussed the kinds of environments that produce psychological distress in primates. The question remains what type of environment promotes psychological well-being. When we turn for answers to ethical research in the wild to complement research on captive chimpanzees, a few clear points emerge. One of the first things that stands out to the ethologist who studies wild chimpanzees is the lack of diversity in the lives of captive chimpanzees (Goodall, 1986; Kortlandt, 1966). As Kortlandt (1966, p. 6) states, this

lacuna exists in the design of the quarters, variety of foods, and environmental conditions and events.

Nothing is more disturbing to a sensitive ethologist than to see a chimpanzee isolated in a small cage. From Kohler (1927) to Yerkes (1943) the paramount importance to a chimpanzee of belonging to a compatible social group has been recognized; it is essential to their very nature. More recently Maple (1978) has reiterated this point. Wild chimpanzees live in large communities ranging from as few as 20 to as many as 120 individuals (Goodall, 1986). Nishida (1979) found that the average size of a group within a chimpanzee community was 12.5 if the alpha male was in it and eight if he was not.

Different management techniques and housing designs based on the chimpanzee's natural environment have been implemented to promote the development of normal behavior and successful reproduction (Reynolds and Reynolds, 1965; van Hoof, 1967; Brambell 1975; Clarke, Juno and Maple 1982). Variables such as temporal variability in biotic conditions and food availability, social opportunities, and structural diversity have been identified (Kortlandt, 1966; Maple, 1978; Dahl, 1982). But the social environment is perhaps the most critical factor in chimpanzee well-being, more important even than design of the living space. Unfortunately, it is seldom given the prominence it deserves. The social environment includes not only the chimpanzees who live together, but also the careproviders and other humans who visit their area. In captivity, the human is part of the chimpanzee social group. This is especially critical where a chimpanzee is isolated from conspecifics. Providing an aesthetically pleasing environment that looks more or less natural is not enough. If you lived in a lavishly furnished condominium with a beautiful view, but were surrounded by people who reviled and shunned you, you would be very miserable indeed.

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Personnel Training

Each new member of our laboratory staff is put through an extensive training program and given a course in "chimpanzee etiquette" prior to any direct contact with the chimpanzees. Beyond teaching our method of collecting data, we give extensive training in the behavior of chimpanzees in general and our chimpanzees in particular, using the data of Goodall (1965; 1968; 1971; 1975; 1986) on the behavior of wild chimpanzees as a guide. We require extensive reading, including our behavioral taxonomy which lists over 200 different kinds of chimpanzee behaviors. We also use training videotapes to aid in analyzing and explaining the different types of chimpanzee behavior.

Staff members have to be accepted by the chimpanzees before they are allowed to stay around them. We know they have been accepted when the chimpanzees no longer direct charging or banging displays toward them. The duration of training depends on the chimpanzees' responses to the new person. Throughout the training process these responses are observed and discussed with experienced staff members. If the new person continues to receive a negative reception after extensive training, we do not allow that person in the chimpanzee areas. Because the chimpanzees cannot leave the laboratory, we believe the least we can do is ensure that they are surrounded by people they like. No one is rushed into a relationship with the chimpanzees; it takes time for good relationships to develop. Moreover, each of the chimpanzees is an individual with a distinct personality, so it may take differing amounts of time before a new person is accepted by all the chimpanzees. Impatient people are reminded that Jane Goodall was at Gombe for over eight months before she could get within 100 meters of the chimpanzees.

Trained staff spend the major part of their time on daily chores and caring for the individual needs of the chimpanzees. We act as maid, cook, and trusted family butler. We clean their rooms, cook three meals, prepare their snacks, ensure they have good magazines available for browsing, and that both the children and adults have interesting toys to play with. We also play the role of understanding and reassuring friend when a family member becomes upset with another. As members of the chimpanzees' extended social group, we try to respond to them as another chimpanzee would. For example, in the wild if chimpanzees are unexpectedly frightened or startled by an unaccustomed sound, they typically seek physical contact with companions by touching, embracing, or kissing (Goodall, 1986). Mason (1965) showed that physical contact had the same calming effect on captive laboratory chimpanzees.

The roles of researcher and careprovider are not separate in our laboratory. Our method of data collection is not much different from the way trusted family servants find things out about the family they serve. They unobtrusively and sometimes covertly observe the family members interacting. We also explicitly train new personnel in the servant attitude, to ensure that human arrogance is avoided.

Our goal of providing variety in a socially enriched environment can be illustrated by describing two aspects of the chimpanzees' daily schedule: meals and free time.

Meals

Variety in meals is one of the easiest forms of enrichment. We prepare three meals a day, serving primarily fruit for breakfast, protein for lunch, and carbohydrates for dinner. Within these guidelines we achieve variety by using different combinations of ingredients. The day's menu is as follows: for breakfast several different fruits are blended with herbal tea for liquid, along with vitamins C and E and nutritional yeast for the B-vitamin complex. For lunch we serve a soup of pinto beans, garbonzo beans, lentils, or split peas cooked with a variety of vegetables; or tuna, eggs, nuts or cheese, all in addition to raw vegetables. For dinner we serve rice, oatmeal, barley, cream of wheat, potatoes, corn, popcorn, etc. The chimpanzees are also offered monkey chow before each meal.

The manner of serving the meal also adds variety. We usually serve in plastic bowls with spoons, but sometimes in plastic bags. We try to make each meal an interesting and enjoyable social event. All the chimpanzees come into one room to be served. Lab members often serve meals with a soft food grunt, sharing in the excitement of a good meal. As in the wild, the most dominant member of the group is usually served first.

Snacks are sometimes offered between meals. This not only provides more dietary variety, but also serves as social enrichment. Examples are shown in Table 1 (See page 7).

Toys, Games, Activities, and Events

A variety of play objects is provided for the chimpanzees throughout the day: magazines, brushes, toys, stickers, unbreakable

plastic mirrors, perfume samples, whistles, play dough, rubber bands, cardboard, large boxes, cloth sacks, a child's pool filled with water, and so on. Many of these items can be hidden inside another; for example, balloons can be hidden in shirt pockets. The chimpanzees often request (through American Sign Language) certain items or activities. In an effort to provide them with a stimulating and varied environment we try to do different things each day. A valuable lesson we have learned is that often the simplest objects are used the most, for example rubber bands, cardboard, empty paper, or cloth sacks (used in games of chase). The chimpanzees will cover their head with a sack or other object and then play a game similar to our human game of Blind Man's Bluff.

Unstructured time is the occasion for a variety of social activities. Sometimes we offer the chimpanzees drawing or coloring materials (nontoxic paints and crayons). Looking at a magazine or a photo album is an activity conducive to interaction between chimpanzees and human. We also play lively games of tickle and chase with the chimpanzees. Because they are in cages, and we have only minimal physical contact with them, we use toys such as plastic dinosaurs and long branches to tickle or touch them. To be an effective play partner, the human uses chimpanzee gestures and vocalizations such as the breathy chimpanzee laughter, playfaces, playwalking, or foot stamping. Television is a special treat and is always shared with a human. These playtimes are not only valuable as a social activity but are also valuable times for data collection. We have conducted research on pragmatics (Bodamer, 1992), context of interaction (Kennerud 1993), vocal comprehension, (Shaw 1989), and television preference (Nabie, 1992) during this unstructured time.

In addition to everyday variety, there is also the variety of special occasions: the chimpanzees' birthdays as well as most of the calendar holidays. This provides for at least one and usually more special days each month. Birthdays include cake with candles, streamers, party hats, cards, balloons, and a variety of treats. The Christmas holidays start shortly after Thanksgiving when we get the Christmas tree and begin to make the edible ornaments. The tree is covered with different edible treats such as nuts, dried fruit, popcorn, and gum. The tree is a popular chimpanzee topic of conversation throughout this period; they make daily, sometimes hourly, inquiries about the availability of the tree's ornaments. These special occasions are examples of our constant battle to break the deadening routine so typical of captivity.

Fruit	Iced treats (frozen in a bowl of ice):
Fruit leather	gum
Decaffeinated coffee (regular and iced)	raisins
Herbal tea	bananas
Sugarless gum	grapes
Cattails (entire plant)	Raisin boards (2" x 4" x 2" board with
Corn stalks (large, tough leaves removed)	drilled holes stuffed with raisins,
Iced tea	accompanied by willow branch tool:
Snow	Water balloons (occasionally filled with
Flowers	fruit drinks, sometimes frozen)

Table I: Examples of snacks given to the chimpanzees.

Conclusion

Many of the activities that occur in our laboratory may be peculiar to us and inappropriate in other settings, but the critical issue has general application: avoid boredom in the chimpanzees by giving them something to do. Because chimpanzees are very social beings, we make a special effort to devise situations conducive to positive social interactions among the chimpanzees and between us and them.

Human/chimpanzee relationships require that the humans understand chimpanzees both as a species and as individuals. We have an extensive training program to accomplish this. A unique social relationship can develop between chimpanzee and his or her human companions. We believe such a relationship is not only possible but is essential for the chimpanzees' psychological well-being given their extremely social nature.

By providing the chimpanzees with a wide variety of things to do we have also created an environment that is conducive to interesting social interactions. This is exactly the type of environment one would expect to help a chimpanzee achieve some measure of psychological well-being. While the chimpanzees benefit by having an enriched and stimulating environment in which they can plan and manipulate objects, science also benefits by having healthy chimpanzees to study.

If careproviders and researchers take the time to understand the chimpanzees' nature and needs, and if they actively strive to accommodate their procedures to those needs, then they begin to learn something very important: "human" and "chimpanzee" are just names for our shared beingness.

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Calendar

February 24–25, Current Issues in IACUC Protocol Review, North Carolina State University.
The following issues will be addressed during this course: assessing the number of animals during protocol review, death as an endpoint, exposure routes in toxicology studies, considerations of alternatives, frequently cited deficienies.
Contact: Department of Continuing Education and Public Program Office, NCSU-CVM, 4700 Hillsborough Strees, Raleigh, NC 27606. (919) 829-4421; fax (919) 829-4283. For program content, contact Thomas E. Hamm, Jr., DVM, Director Laboratory Animal Resources, (919) 829 4280; fax (919) 829-4283.

May 5–6, Training and Education: Institutional Improvement—Crisis Prevention
The general theme will focus on continuing education and training mandated by the National Institutes of Health and USDA. The format will include panel discussions and concurrent breakout sessions. The group discussions will address occupational health; analgesia, pain, and surgery; euthanasia; and tailoring the CET programs to specific audiences
Contact: Ms. Lisa D. Snider, Administrative Assistant, Laboratory Animal Program, Purdue University, 1071 South Campus Courts-D, West Lafayette, IN 47907-1071. (317) 494-7206, fax (317) 494-0793.