

The Use of Positive Reinforcement Training Techniques to Enhance the Care, Management, and Welfare of Primates in the Laboratory

Gail E. Laule

*Active Environments
Lompoc, California*

Mollie A. Bloomsmith

*TECHLab
Zoo Atlanta, and
Yerkes National Primate Research Center
Atlanta, Georgia*

Steven J. Schapiro

*Department of Veterinary Sciences
The University of Texas M. D. Anderson Cancer Center*

Handled frequently and subjected to a wide range of medical procedures that may be particularly invasive, nonhuman animals in a laboratory setting have unique needs. To produce the most reliable research results and to protect and enhance the well-being of the animals, it is desirable to perform these procedures with as little stress for the animals as possible. Positive reinforcement training can use targeted activities and procedures to achieve the voluntary cooperation of nonhuman primates. The benefits of such work include diminished stress on the animals, enhanced flexibility and reliability in data collection, and a reduction in the use of anesthesia. Training also provides the means to mitigate social problems, aid in introductions, reduce abnormal behavior, enhance enrichment programs, and increase the safety of at-

tending personnel. This article describes the application of operant conditioning techniques to animal management.

The care and management of nonhuman animals in laboratories and zoos has evolved dramatically in the last 15 years. In the United States, the major impetus for change was the Animal Welfare Act (1987), which mandated that the psychological well-being of nonhuman primates and dogs be adequately addressed. By singling out these two specific groups of animals, the spotlight focused initially on the biomedical community, which was the first community to take action. They tackled the daunting task of determining what “psychological well-being” meant because nowhere was it clearly defined. This effort produced a thoughtful exploration of current animal care and management practices that was incredibly productive and much needed. Over the years, valuable information resulted from this process, including a number of excellent publications for example: Segal, 1989; Novak and Petto, 1991; Norton, Hutchins, Stevens, and Maple, 1995; and Shepherdson, Mellen, and Hutchins, 1998.

During this time, interest and support for the idea of using positive reinforcement training (PRT) to enhance the care and welfare of captive animals was also growing. The marine mammal community had been using PRT for many years to train dolphins and sea lions to do all those entertaining “tricks” the public loved to see. This community was also the first to recognize that those same techniques could be used to improve the care and welfare of these animals by gaining their voluntary cooperation in husbandry and veterinary procedures. It was through the handling of two performing male sea lions that the first author discovered a technique for reducing aggression and enhancing positive social interaction that is referred to as *cooperative feeding* (Laule & Desmond, 1991). In time, a PRT approach to captive animal management spread in many different contexts to the zoological and biomedical communities and, subsequently, to a vast array of species. Today, PRT is recognized more and more as an essential tool for the humane and effective management of captive animals. Now, too, greater effort is being placed on measuring the effects of training and the effectiveness of specific training techniques (McKinley, Buchanan-Smith, Bassett, & Morris, 2003/this issue; Schapiro, Bloomsmith & Laule, 2003/this issue). Addressing the needs of laboratory animals while meeting research objectives and implementing protocols should be the goal of every biomedical facility.

In this article we describe the application of operant conditioning techniques to a real-world animal management situation. Although we recognize that objective, operationally-defined terminology is an important part of the scientific endeavors of behavior analysts, we choose to use more casual language in this article. We believe that this style will be of more value to those who might apply the techniques to the nonhuman primates for whom they care.

OPERANT CONDITIONING

When we consider the impact of training on animal care and welfare, it is important to remember just what training is. *Training* is teaching. We teach animals to make a movement, to hold a position, or to tolerate a particular stimulus. To be an effective teacher or trainer requires the following attitudes and skills: (a) a high degree of patience, (b) empathy with your subject, (c) a cooperative relationship, (d) the ability to teach pieces that add up to the whole, and (e) the flexibility to adjust to what your subject “gives” you. Teaching and training require a willing subject who participates in the process, not a passive recipient of actions that are outside the subject’s control.

It also is important to choose your training approach carefully. The fundamental principle of operant conditioning is that behavior is determined by its consequences. Behavior does not occur as isolated and unrelated events; the consequences that follow the actions of an animal, be they good, bad, or indifferent, will have an effect on the frequency with which those actions are repeated in the future. Operant conditioning offers two basic options for managing behavior: positive reinforcement and negative reinforcement or escape/avoidance. Both increase the chance that a behavior will occur. In a positive reinforcement-based system, animals are rewarded with something they like for responding appropriately to the caregiver’s cues or commands. Operationally, we are gaining the animal’s voluntary cooperation in the process. This differs from negative reinforcement training in which the animal performs the correct behavior to escape or avoid something unpleasant or aversive.

In the real world, it may not be feasible to utilize positive reinforcement exclusively. Our working principle is that the positive alternatives should be exhausted before any kind of negative reinforcement is employed. On the rare occasions when an escape-avoidance technique is necessary, its use should be kept to a minimum and balanced by using positive reinforcement the majority of the time.

Negative Reinforcement Training

Unfortunately, laboratory animal management practices traditionally have included a large measure of training through negative reinforcement. Although these techniques “get the job done,” it could be argued that there is an inherent cost to the animal’s overall welfare to be forced to cooperate through the threat of a negative event or experience that elicits fear or anxiety (Reinhardt, 1992).

Consider the animal who must receive an injection for a research protocol. Without training, the animal has no choice in how that event occurs. If negative reinforcement or escape/avoidance training is used, offering a choice—present a leg for the injection—requires the threat of an even more negative stimulus (a

net or squeeze-cage back panel moving), thus exposing the animal to distress from both stimuli. Using a PRT approach, the animal is trained through shaping and rewards to present a leg voluntarily for an injection and concurrently desensitized to the procedure to reduce the associated fear or anxiety. When the injection is needed, it would seem logical to argue that having a clearer choice in how that event happens, and being less fearful of it, contributes to that animal's psychological well-being.

PRT

PRT techniques can provide the means to address a wide range of behavioral issues with primates in the laboratory. Training provides the tools to improve husbandry and veterinary care (Desmond & Laule, 1994; Reichard, Shellabarger, & Laule, 1992; Reinhardt, 1997; Stone, Laule, Bloomsmith, & Alford, 1995); reduce abnormal and/or stereotypic behavior (Laule, 1993); reduce aggression (Bloomsmith, Laule, Thurston, & Alford, 1994); improve socialization (Desmond, Laule, & McNary, 1987; Schapiro, Perlman, & Boudreau, 2001); enhance enrichment programs (Kobert, 1997; Laule & Desmond, 1998); and increase the safety of the attending personnel (Bloomsmith, 1992; Reinhardt, 1997). It also may improve the relationship between people and the animals in their care (Bayne, Dexter, & Strange, 1993; Bloomsmith, Lambeth, Stone, & Laule, 1997).

Training laboratory primates to cooperate voluntarily in husbandry, veterinary, and research procedures seems to have significant benefits for the animals. Animals are desensitized to frightening or painful events, such as receiving an injection; so the events become less frightening and less stressful (Moseley & Davis, 1989; Reinhardt, Cowley, Scheffler, Vertein, & Wegner, 1990). Voluntary cooperation reduces the need for physical restraint and/or anesthesia and, thus, the accompanying risks associated with those events (Bloomsmith, 1992; Reinhardt, Liss, & Stevens, 1995). Training can enhance animal welfare by providing animals the opportunity to work for food (Neuringer, 1969); achieve greater choice and control over daily events (Mineka, Gunnar, & Champoux, 1986); experience greater mental stimulation (Laule & Desmond, 1992); and experience other enriching results such as reduced self-directed behaviors, increased activity, and enhanced social interactions (Bloomsmith, 1992; Desmond et al., 1987; Laule, 1993). All these factors have been associated with enhanced psychological well-being (Hanson, Larson, & Snowdon, 1976; Markowitz, 1982).

Experience has shown that animals trained with positive reinforcement maintain a high degree of reliability in participating in husbandry and veterinary procedures and are less stressed while doing so (Reinhardt et al., 1990; Turkkan, Ator, Brady, & Craven, 1990). Investigators report evidence of these results in a variety of primate species including reductions in cortisol levels, stress-related abortions,

physical resistance to handling, and fear responses such as fear-grinning, screaming, and acute diarrhea (Moseley & Davis, 1989; Reinhardt et al., 1990). Finally, many husbandry and veterinary procedures can be implemented with minimized disruption to all animals because the need to separate animals from their social groups for these procedures is reduced (Bloomsmith, 1992).

PRT Techniques

The following are a selection of training techniques that are valuable in a variety of management situations for nonhuman primates in a biomedical setting.

Conditioned reinforcer (bridge). This is an initially meaningless signal that over time, when repeatedly paired with a primary reinforcer (i.e., food), becomes a reinforcer. The most appropriate conditioned reinforcer in the laboratory setting is a hand-held clicker or a verbal “good.” The conditioned reinforcer offers the trainer a way to communicate precisely to the animal the exact moment a desired behavioral response occurs. It’s a way of saying, “Yes, that’s exactly what I want,” which is valuable information for the animal and can enhance learning.

Target. A *target* is an object the animal is trained to touch. Targets can be made of various objects: a dowel or stick, plastic bottle, or a clip that can attach to the caging material. The target is a point of reference toward which the animal moves and is useful in several ways. First, the caregiver can control gross movement by rewarding the primate for moving toward the target when it is presented or for going to a target preplaced elsewhere in the cage. Second, the animal can be trained to stay at the target for a period. Socially housed primates can be trained to remain at their own target while the caregiver interacts with an individual animal in the group, thus eliminating the need for physical separation. Third, the target can facilitate control of fine movement by teaching the animal to touch the target with foot, arm, chest, back, or ear.

Shaping or successive approximation. *Shaping* is the process by which behaviors are taught. Shaping consists of dividing a behavior into small increments or steps and then teaching one step at a time until the desired behavior is achieved. The key to successful shaping is the ability to identify steps that are appropriate to the behavior being trained and the animal learning it. Too large steps can create confusion and frustration in the animal. Too small steps can lead to loss of motivation and boredom. The following is an example of one potential shaping plan to train the primate to present a leg for venipuncture.

1. Use a target to encourage the animal to move to the front of the cage.
2. Reinforce for staying at the target for increasing periods of time.

3. Secure the target at a height that encourages the animal to sit and reinforce when this occurs.
4. Use a second target to focus attention on desired leg; reinforce any movement of the leg towards the target.
5. Open the port in the cage and target the leg out through the opening until the leg is fully extended.
6. Reinforce for keeping the leg in that position for increasing periods of time.

Desensitization. *Desensitization* is a highly effective training tool that can help laboratory primates tolerate and eventually accept a wide array of frightening or uncomfortable stimuli. By pairing positive rewards with any action, object, or event that causes fear, that fearful entity slowly becomes less negative, less frightening, and less stressful. Animals can be desensitized to husbandry, veterinary, and research procedures, new enclosures, the squeeze cage, unfamiliar people, negatively perceived people such as the veterinarian, novel objects, strange noises, and any other potentially aversive stimuli. Effective desensitization requires pairing many positive rewards directly with the uncomfortable or aversive experience or with a similar experience. That requires precise reinforcement so that the conditioned reinforcer (bridge) occurs at the exact moment the animal experiences the stimulus. When desensitization is done well, animals are likely to cooperate voluntarily with behaviors with little or no sign of recognizable stress or fear.

Desensitization is a very powerful, versatile, and valuable technique that should be used whenever the animal shows signs of fear or discomfort in relation to any event. In the previous shaping plan example, desensitization would train the primate to accept the actual needle piercing the skin. The following series of steps illustrate the desensitization process.

1. Touch the leg at blood collection site with a finger or blunt object; bridge when the object touches the skin and then reinforce; repeat until the animal shows no fear or discomfort; repeat desensitization process with following objects: capped syringe, a needle with the tip cut off so it is blunted, syringe with the real needle.
2. Extend the length of time the object touches the skin.
3. Desensitize the primate to the touch and smell of alcohol swab.
4. Desensitize the animal to the presence of a second person, then to the presence of the veterinarian or technician.

Cooperative feeding. It is most desirable to house naturally social animals, like primates, in pairs or groups (de Waal, 1987). However, because of the constraints captivity imposes on animals and their ability to avoid or escape negative behavior, social housing must be carefully implemented and monitored, or it can become a stressful and even dangerous experience for subordinate animals (Coe,

1991; Crockett, 1998). Using a training technique we call *cooperative feeding*, it is possible to enhance introductions, mitigate dominance-related problems, increase affiliative behaviors, and reduce aggression in socially housed animals (Laule & Desmond, 1991). Operationally, this entails reinforcing two events within the group simultaneously: Dominant animals are reinforced for allowing subdominant animals to receive food or attention, whereas the subdominant animals are reinforced for being “brave” enough to accept food or attention in the presence of these more aggressive animals.

It is important to note that dominance is not eliminated; in fact, it is acknowledged. Aggression is a normal component of social behavior; therefore, the goal is to reduce aggression to an appropriate and acceptable level. Cooperative feeding can help ensure that all individuals—not just the stronger or more dominant ones—enjoy a quality of life. Studies have shown significant reduction of excessive aggression (Bloomsmith et al., 1994) and an increase in affiliative behaviors as a result of the training (Cox, 1987; Desmond et al., 1987; Schapiro et al., 2001; Schapiro et al., 2003/this issue).

AN ANIMAL MANAGEMENT INVENTORY

We suggest that the first step in moving toward a more positive reinforcement-based management system is to take an inventory of current practices. Identify the daily and as-needed interactions that occur between an animal and staff members. The activities may include (a) visually inspecting the animal; (b) cleaning and feeding; (c) human/animal interacting for enrichment; (d) providing food or object enrichment; (e) moving animals from one location to another; (f) introducing or separating animals; and (g) performing veterinary procedures or research protocols.

The next step is to identify the management practice (positive or negative reinforcement) used in each interaction. Are the animals provided a clear cue or signal and then given the opportunity to cooperate in the procedure in exchange for something they like (a treat, attention, verbal praise)? Are the animals “made” to cooperate through the threat of something negative (a net, squirt of water, use of a squeeze mechanism, human intimidation, or physical restraint)?

Such an inventory can yield surprises. It also is a reminder that training—whether we recognize it or not—is occurring all the time, and so is learning. Unless we are aware of what we are reinforcing, and what we are not, a lot of unwanted learning can result. The approach used to collect monthly urine samples from cycling female chimpanzees (*Pan troglodytes*) at one facility involved moving the female out of her homecage and into a clean transport cage. A caregiver would then give her juice from a squirt bottle and wait until she urinated. The longer the chimp did not urinate, the more juice she got. She was be-

ing unintentionally reinforced and, thus, “trained” to wait as long as possible before urinating.

An inventory of this kind also can reveal behaviors or negative coping strategies that are likely to be related, in some degree, to the handling practices employed. Reliance on negative reinforcement techniques can lead to avoidance, aggression, fear, self-aggression, and stereotypic behavior on the part of the animal. Given the benefits that PRT offers the animals, the staff, and the institution, it is desirable to identify specific interactions that currently are being managed through negative reinforcement and to evolve those slowly into a PRT-based approach.

EVOLVING INTO A PRT SYSTEM

Primates in the laboratory environment have unique care and management requirements, and there often are significant limitations placed on the staff to meet those needs. Usually, caregiver staff is responsible for large numbers of animals and a population that may change frequently. Often, staff is given only short periods to prepare animals for research procedures. Housing conditions vary from small caging that severely restricts the animal’s range of physical movement to big corrals with large numbers of animals that are difficult to access on an individual basis. Research protocols often dictate or restrict an animal’s amount and type of food, type of physical activity, ability to live in social housing, and acceptable enrichment options.

These conditions of life in the laboratory make a formal PRT program difficult to implement. However, it is feasible to integrate PRT into existing management procedures to improve the care and welfare of resident primates. To develop such a system, the following actions are recommended:

1. Provide some basic training in PRT techniques to all animal care staff. By developing staff who are familiar with these techniques and have some degree of competence in using them, the quality of care of laboratory animals can be greatly improved.
2. Incorporate PRT into interactions with animals for daily management and to gain cooperation for veterinary and research procedures. Give animals the opportunity and motivation to cooperate voluntarily in these procedures. Caregivers should provide clear cues for desired responses, and reinforce those responses when they occur.
3. Exercise patience. To increase success, give animals a reasonable opportunity to cooperate in the desired behavior.
4. Plan ahead and actively prepare animals for veterinary procedures, research protocols, or any foreseen changes in the routine such as altering social groups or environmental factors.

CONCLUSIONS

The use of PRT as an animal care and management tool offers many benefits to biomedical facilities and to their animals, staff, and researchers. It allows managers to address proactively a wide range of situations that have significant implications for animal care and welfare. Primary among these is the ability to gain the voluntary cooperation of animals in husbandry, veterinary, and research procedures. Desensitization can significantly reduce the fear and stress associated with these procedures. Training can be applied in a wide array of situations. When appropriately and skillfully applied, PRT represents a viable option to the traditional approach to the management of animals in the laboratory. Making the shift to a more positive reinforcement-based system significantly enhances the welfare of the animals.

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