

Implementing positive reinforcement animal training programs at primate laboratories

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ABSTRACT

In the last decade several surveys of primate care and training programs highlight a common theme; despite scientific evidence that animal training can be effective in reducing stress, increasing efficiency and improving veterinary care, animal training is not widely incorporated into animal care and management programs in laboratory settings. This is particularly important with the recent release of the internationally recognized version of the "Guide for the Care and Use of Laboratory Animals" by the National Research Council. The Guide includes multiple recommendations to incorporate training methods into husbandry and experimental procedures. To address the divide between the regulatory and scientifically based support for animal training, and a broader establishment of formal animal training programs, this paper will: describe three approaches to structuring animal training programs; provide rationale as to why facilities should have animal training programs; report on a recent survey of animal training programs at nine, large USA facilities housing nonhuman primates; discuss important elements of an animal training program; discuss negative reinforcement and means to minimize its use; and finally give a detailed description of a facility-wide animal training program.

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1. What is a laboratory primate training program?

The systematic application of operant and classical conditioning techniques to training primates living in laboratory facilities has become much more common over the last two decades (Bloomsmith et al., 1998; Clay et al., 2009; Coleman et al., 2008; Fernstrom et al., 2009; Laule et al., 1996, 2003; Perlman et al., 2010; Reinhardt, 1997; Schapiro et al., 2003, 2005). A major development in this

field has been extending the use of positive reinforcement training (PRT) techniques to increase the primates' cooperation with animal management and research procedures. There have been a large number of publications describing training technique, training terminology and various uses for training (Bloomsmith et al., 2007; Coleman and Maier, 2010; Kazdin, 2001; Laule and Whittaker, 2001, 2007; Ramirez, 1999; Schapiro et al., 2005). However, issues related to designing and initiating animal training programs have been less well described. Animal training programs are an important refinement in the care of laboratory primates as they can help to reduce stress experienced by animals and improve their research use by minimizing this confound. The programs may include dedicated personnel, education programs, routines

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to increase consistency among trainers, documentation systems, and evaluation of trained animals. The objective of this manuscript is to assist those caring for laboratory primates in the development of new, or in the refinement of existing, primate training programs.

2. Three approaches to structuring animal training programs

Animal training programs generally fall into three categories: project-based programs, section-wide programs and facility-wide programs (Whittaker et al., 2008). Within one institution, multiple approaches may be simultaneously operating or programs may evolve from one type of structure to another. It is essential to understand the focus and breadth of the training program to maximize effectiveness for the animals and staff. Using the framework presented here, one can determine which approach is best suited for the animal care needs and goals of the institution.

2.1. Project-based approach

A project-based training program typically includes a few animals or groups of animals and a limited number of staff. Specific behavioral objectives can be addressed. For example, one group of primates may be trained: (1) by the primary caregiver to shift from one area to another; (2) by the veterinary technician to present an arm for ointment application; and (3) by a lab technician to calmly present for pole attachment to the collar. Resulting benefits of the project-based training approach include a positive influence on animal welfare with the application of PRT to improve voluntary animal cooperation, and job satisfaction is often enhanced for the person(s) implementing the training who may take great pride and ownership in the training project. If successful, other technicians may take notice of the training accomplishment and may be motivated to incorporate training into their daily routine. A project-based approach can serve as the catalyst for other training projects, and help build the foundation for the facility's animal training program. Project-based projects, when successful, can expand to a section-wide approach.

There are common drawbacks of a project-based approach. This approach typically does not receive the institution's full support, particularly with regard to the dedication of time and monetary resources. Training is a skill that must be developed, and with this approach, support for continuing education such as conference or workshop attendance is limited. Additionally, supervisor oversight may be minimal, which may result in compromised safety of the trainer or the animal when technique, facilities, and protocols are not adequately assessed. Once animals are trained by the primary trainer, behaviors should be transferred to others. In the absence of direct supervision, this process may be difficult to implement, therefore reducing the scope of application for both the animals and institution. Finally, few animals benefit from the training conducted in a small project, and the project may not persist if the motivated primary trainer leaves the facility.

2.2. Section-wide approach

A section-wide approach to training is typically supported within a particular department or research laboratory by the manager, and involves staff implementing training toward specific objectives. For example, the objective may be training all primates in a particular laboratory to calmly move into a restraint chair. This section-wide approach typically involves a subset of animals at a facility, and there may be support for continuing education and skills development. Due to the broader scope of this approach, when applied properly, animal management will be improved for that particular area or section, and oversight of safety for animals and humans is available. If successful, the example may serve as an impetus for changes in other departments or laboratories within the facility and, over time, development of a facility-wide approach may occur.

One drawback of a section-wide approach is limited communication among all those working with the same animals. For example, animals will be trained to calmly move into a restraint chair for research purposes but similar animal movement activities, such as calmly entering a transfer box for animal care purposes, would unlikely benefit. Further, if an animal is assigned to another study with a different manager, there may be little communication between managers regarding the training the animal received. The program may not persist if the manager leaves his/her position.

2.3. Facility-wide approach

The most comprehensive is the facility-wide approach to structuring a training program. This program is implemented throughout the institution and is supported by multiple management and departmental levels including animal care, veterinary staff, colony management, behavioral management, research groups, administration, occupational health and safety, facility or operations managers, and perhaps even public relations or regulatory oversight committees (e.g., Institutional Animal Care and Use Committee, IACUC). Many more people and animals are positively impacted in comparison to the other approaches. The institutional commitment to the facility-wide training program is demonstrated by hiring for dedicated positions, supplying continuing education opportunities and training for staff, providing the necessary tools, facility modifications and safety oversight. Training responsibilities are included in appropriate job descriptions and supervisors ensure accountability for training responsibilities. Goals and objectives of the training program are communicated throughout the facility. Progress toward centralized training goals are assessed and refined, as needed, to move the program forward. A facility-wide training approach creates a framework of safety, education, consistency and communication for the multiple project-based and section-wide training applications that are often present in larger institutions.

There are few drawbacks to such a facility-wide program, but they are significant. Development and implementation of such a program takes time and monetary

resources. There are significant costs associated with hiring additional personnel, providing training and continuing education to all staff involved, modifying facilities and providing supplies to support the training program. Additional drawbacks are staff frustration with perceived additional responsibilities and time expenditure, as well as lack of interest to “fix what ain’t broke”.

3. Why primate facilities should have animal training programs

3.1. Regulatory compliance

There is increased interest from regulatory agencies on the effects of animal training on the welfare of non-human primates. The recent version of the *Guide for the Care and Use of Laboratory Animals* (2011) emphasizes the importance and benefits of animal training programs with the following recommendation: “Habituating animals to routine husbandry or experimental procedures should be encouraged whenever possible as it may assist the animal to better cope with a captive environment by reducing stress associated with novel procedures or people. The type and duration of habituation needed will be determined by the complexity of the procedure. In most cases, principles of operant conditioning may be employed during training sessions, using progressive behavioral shaping, to induce voluntary cooperation with procedures” (pp. 64–65). In a 2010 report of site visits to chimpanzee facilities in the United States of America, The Office of Laboratory Animal Welfare (OLAW) also supported the notion that PRT may help in reducing stress and concluded that when safe and feasible, nonhuman primates should be afforded positive reinforcement training opportunities (OLAW, 2010).

3.2. Stress reduction

Experience has shown that trained animals consistently voluntarily participate in veterinary and research procedures, and are less stressed while doing so (Lambeth et al., 2006; Reinhardt et al., 1990; Turkkan, 1990). Training laboratory animals to cooperate reduces the need for physical restraint and/or anesthesia, and thus reduces the stress that accompanies those procedures. Evidence for stress reduction includes reductions in cortisol levels, stress-related abortions, physical resistance to handling, and fear responses such as fear-grinning, screaming, and acute diarrhea (Clay et al., 2009; Moseley and Davis, 1989; Reinhardt et al., 1990; Verstein and Reinhardt, 1989). Chimpanzees who voluntarily presented for injection of an anesthetic agent had significantly reduced physiological measures of stress when compared to those who did not cooperate and were anesthetized via chemical darts (Lambeth et al., 2006). These results were supported by within and between subjects’ comparisons. A study evaluating the effect of PRT on cortisol, hematology and cardiovascular measures in cynomolgus macaques found subjects exposed to daily PRT sessions showed decreased measures of stress compared to those not exposed to PRT (Koban et al., 2005).

3.3. Increase the efficiency of working with primates

Although animal training requires an initial time investment, it can lead to a savings in the personnel time required for some tasks over the long-term. Many procedures, such as moving primates within their enclosures for cleaning, transporting them between enclosures and collecting biological samples, can be completed much faster once the primates have been trained. McKinley et al. (2003) reported saving 91% of the time required to weigh a marmoset by training them to target at the front of the cage and climb onto the scale (174.25 s reduced to 159.5 s). Veeder et al. (2009) trained a group of mangabeys to move from one area of the enclosure to another for cleaning, saving 46 min a day of animal care staff time. The total training time required was recouped in fewer than 35 days. PRT also improves the ability to collect samples without requiring anesthesia or social separation. Stone et al. (1994) quickly and reliably obtained urine samples from chimpanzees without necessitating social isolation, and Kelley and Bramblett (1981) had similar results with a group of vervet monkeys.

3.4. Improve veterinary care and research

Training facilitates veterinary care by improving the ability to conduct procedures, and observe animals more closely and more frequently without the use of anesthesia or restraint. Primates voluntarily participate in procedures such as conscious blood collection (Coleman et al., 2008; Laule et al., 1996), urine collection (Laule et al., 1996; Perlman et al., 2010; Stone et al., 1994), subcutaneous injections (Perlman et al., 2004; Schapiro et al., 2005), and voluntary intramuscular injections for anesthesia, antibiotics or vaccines (Lambeth et al., 2006; Schapiro et al., 2005; Videan et al., 2005).

3.5. Provide opportunities for choice and control

PRT enables animals to learn about the consequences of their actions and it relies on their voluntary participation (Bassett and Buchanan-Smith, 2007). If there are welfare benefits to training that are above and beyond the benefits of having animals conditioned to calmly and efficiently comply with various husbandry, research and veterinary needs, then this is another reason to invest time and resources into animal training programs. The data on primates indicate that experience with controllable events fosters exploration, enhances performance on cognitive tasks, and may attenuate stress reactivity (Hanson et al., 1976; Mineka et al., 1986; Roma et al., 2006; Washburn et al., 1991). These are positive contributions to psychological well-being (Novak and Suomi, 1988) and PRT may provide similar benefits to well-being by stimulating activity that offers primates choice and control over some aspects of their environment.

3.6. Enhance social housing

There are challenges with managing social groups of primates that can be addressed through PRT techniques. One particularly useful technique, known as cooperative

feeding (Bloomsmith et al., 1994; Whittaker, 2005) involves reinforcing the dominant individual for allowing subordinate group members to have desirable resources such as food, enrichment, or attention from a caregiver. This technique can reduce fighting during meal times (Bloomsmith et al., 1994). To further enhance socialization, primates can be taught to tolerate proximity to one another, and to touch each other gently (Cox, 1987; Desmond et al., 1987; Schapiro et al., 2001). This type of training has potential to benefit the process of introducing unfamiliar primates to one another (Laule and Desmond, 1990). A more advanced technique, collaborative training, involves training animals to work together toward a common goal by rewarding their mutual efforts (i.e. two individuals are rewarded for working together to move an object). The use of collaborative training to purposefully create social ties may also enhance social relationships (Laule and Whittaker, 2007).

3.7. Address behavioral problems

Scientists have evaluated PRT's impact on behavioral problems to determine whether it can reduce, eliminate or prevent the expression of problematic behaviors, and whether these treatment effects generalize to the primates' overall behavioral repertoire (Baker et al., 2010; Bloomsmith et al., 2007).

3.7.1. Stereotyped behavior

Training can reduce stereotyped behavior (behavior that is repetitive, invariant and seems to be without function, such as pacing or repeated flipping, Mason, 1999) during the period of time the trainer is working with the primates (Bloomsmith et al., 1997; Morgan et al., 1993). However there are conflicting findings as to whether PRT has a generalized effect on abnormal behavior of primates outside of training sessions: two studies showed no such generalization (Baker et al., 2009; Bloomsmith et al., 1997), while three other studies did show a generalized decrease in stereotypes when the trainer was not present (Bourgeois and Brent, 2005; Coleman and Maier, 2010; Pomerantz and Terkel, 2009). Training behaviors that are incompatible with the stereotyped behavior may be an effective therapy (e.g., reinforcement for remaining still, for subjects that were pacing) (Bourgeois and Brent, 2005). PRT may help to prevent the development of stereotyped behavior, as has been found with young nursery-reared rhesus monkeys (Brunelli et al., 2009). Combining PRT with other treatment approaches (social group manipulations, drug therapy) reduced the extreme stereotyped behavior in a male bonobo (Prosen and Bell, 2000). While there does seem to be promise in using PRT as a treatment and perhaps even as a preventative measure, it is important to note that in no studies did the training eliminate stereotyped behaviors.

3.7.2. Self-injurious behavior (SIB)

Several studies have evaluated whether SIB can be modified through training. A chimpanzee exhibiting SIB was successfully treated with a combination of therapies including enrichment, socialization, drug therapy and PRT

(Bourgeois et al., 2007). Staff avoided the chimpanzee when he was exhibiting behaviors associated with his SIB, he was trained to perform an incompatible behavior, and he was desensitized to arousing stimuli. In combination with intensive enrichment, socialization changes and drug therapy, the training significantly reduced his SIB for several years (S. Bourgeois, pers. comm.). A similar combination approach was used by Prosen and Bell (2000) with a bonobo who exhibited a great deal of SIB, and it was very successful in reducing his SIB.

In another study, SIB in a baboon was reduced using a functional analysis (FA) technique (Dorey et al., 2009). FA is an assessment technique used in humans to treat behavioral problems by systematically identifying what is reinforcing a specific behavior, and then manipulating that reinforcement. Since the FA revealed the SIB was positively reinforced by human attention, during treatment SIB was ignored by staff, and the behavior decreased. This FA approach, while time intensive, shows promise in the treatment of some behavioral problems in nonhuman primates.

3.7.3. Fear and aggression

Fearful behavior in singly housed laboratory primates has been successfully treated with PRT. Individuals who showed fear responses to specific, routine husbandry tasks (e.g. removing food from a cage, spraying water from a hose) were desensitized to these experiences, and they displayed significantly less fearful responses than those study animals given additional time to acclimate to their environment, or those who underwent basic husbandry training (Clay et al., 2009). A recent study using PRT techniques to reduce rhesus macaque aggression toward humans was effective in reducing the behavior during and outside of training sessions (Minier et al., 2011).

3.7.4. Feces throwing

A FA approach was used to assess feces throwing by a chimpanzee, and confirmed that human attention was reinforcing this behavior (Martin et al., 2011). The subject was trained to touch a specific target, or a "functional communication tool" which served as a request for the human caregiver to give positive attention to the chimpanzee which reduced the undesirable behavior by about 80%. This effect generalized in the presence of unfamiliar people.

4. Status of training programs at National Primate Research Centers

A survey was conducted in 2009 in an effort to assess the state of PRT programs within National Primate Research Centers (these are large, specialized primate facilities supported by National Institutes of Health [NIH] to conduct biomedical and behavioral research) in the United States of America. The survey consisted of 28 questions in four sections and basic terminology was defined within the survey (see Appendix). The survey respondents included the eight National Primate Research Centers (NPRCs) and one NIH facility (henceforth "facilities"). The survey was compiled by two of this paper's authors, BM and DEM. Answers to survey questions were completed

Table 1

Components involved in the development of an animal training program.

	Efforts to engage training program? Response % and count (N = 9)		Most effective at gathering support? Response % and count (N = 8)	
Begin training small numbers of animals	89%	8	63%	5
Initiated training under research studies	78%	7	38%	3
Presentation incl. slides or video	67%	6	63%	5
Senior staff meetings/discussions	56%	5	25%	2
Invited speakers	56%	5	38%	3
Write/acquire standard operating procedures	56%	5	13%	1
Junior staff meetings/discussions	44%	4	13%	1
All staff forum or technical education classes	44%	4	38%	3
Training demonstrations	44%	4	13%	1
Journal or club readings	44%	4	0%	0
Formation of an interest group	33%	3	0%	0
Hired part-time trainer	33%	3	0%	0
Hired full-time trainer	33%	3	25%	2

electronically, and were based on the state of the facilities' animal training programs at that time. Each facility had the option to respond or not to each question listed and some questions were not answered by all facilities; therefore the number of responses for each question is indicated in the information below.

4.1. Survey summary, animal training programs

Of the nine reporting facilities, all indicated that they trained both singly and socially housed primates. Four had formalized or documented animal training programs, and five reported they were in the process of formalizing an animal training program, but that resources such as staff time (three of five), funding (two of five), and qualified staff (two of five) were impeding the implementation. All nine facilities reported animal training programs had been, or were being initiated by the behavior management units, with animal care and husbandry (two of nine) and research and investigation (one of nine) also reported as training program initiators. The respondents reported that their animal training programs were created to assist research personnel (eight), animal care and husbandry personnel (seven), and both behavior management and veterinary care personnel (six).

Two methods were identified as the most effective for garnering institutional support for animal training programs (five of eight responding facilities): a presentation using slides or video; and beginning training with a small number of animals (see Table 1). This suggests that demonstration via visual examples of animal training piques staff interest and that small, pilot training projects are effective in gaining institutional support.

Three of five responding facilities agreed that having full-time staffing was a benefit to formalizing their animal training program, and two others stated either that it would have been easier to start with full-time staff, or that they never had full-time training staff and believe this is why the animal training program has not been fully engaged. In total, five full-time (four within a behavior management program and one in a hybrid behavior management and animal care position) and 26 part-time trainers (11 within behavior management programs, 5 within animal care programs, 10 in other programs) were employed in the

facilities. This suggests a growing trend in animal training expertise and implementation. The majority of formalized animal training is conducted by behavior management staff, followed by research staff and animal care and husbandry staff, who are reported to train about the same number of primates.

Five of the nine facilities reported the ways in which their training programs are managed (see Table 2). The remaining four facilities noted a combination of these components is in development or they are managing animal training on an animal-by-animal or as-needed basis.

4.2. Survey summary, behaviors and techniques

Despite most facilities maintaining animal numbers in the thousands, and increased resources being directed toward the development of training programs, relatively few animals were reported as being trained in formalized programs (Fig. 1). This finding probably is due to the early stage of development of many of the training programs.

All facilities indicated the use of shaping by approximations as a PRT method, six facilities used both active desensitization and cooperative/collaborative training methods (see Bloomsmith et al., 1994; Reinhardt, 2003; Schapiro et al., 2001; Wilson and Davison, 1971 for description of the methods), and four facilities used contra-aggression training for human-directed aggression (see Bloomsmith et al., 1994; Clay et al., 2009; Minier et al., 2011 for description of the method). PRT was used to train all of the specific husbandry and research behaviors described in

Table 2

Facility management of an animal training program.

	Response % and count (N = 5)	
How does your facility manage animal training?		
Training Coordinator	80.0%	4
Training Courses or Seminars	80.0%	4
IACUC Approval	60.0%	3
Training Program Manual	40.0%	2
Standard Operating Procedures	40.0%	2
Training Committee	40.0%	2
Training Forum or Discussion Group	20.0%	1
Training Certification	20.0%	1

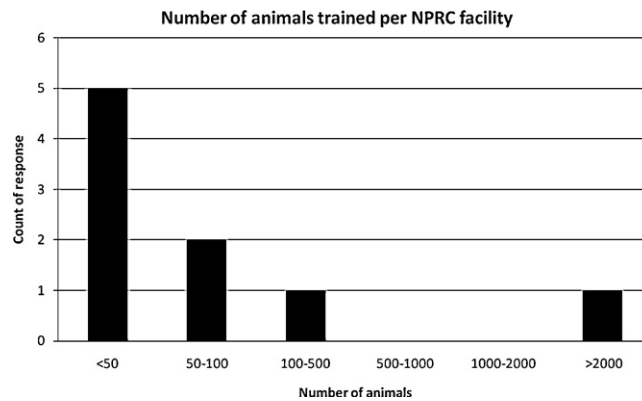


Fig. 1. In the National Primate Research Center survey, relatively few animals are reported as receiving training in formalized programs despite the large number housed at each facility.

Table 3, and negative reinforcement training (NRT) was also applied for some behaviors. Punishment methods were not used to train animals at any facility.

4.3. Survey summary, benefits and current constraints

Constraints on the formalization of training programs were reported and may be based on real or perceived concerns. Monetary expense was reported as the highest concern (see Table 4). Half of the facilities listed concerns about increased staff injury, research interference, and decreased quality of animal care due to time spent training, and non-generalization of training to other staff. When asked to list the most beneficial part of having PRT programs at their facility, five of the seven responding facilities reported increased efficiency in animal care, increased efficiency in veterinary care, and increased animal well-being (Table 5). The prevalence of training benefits and concerns may be associated with the low number of formal training

Table 4

Facility concerns about animal training programs.

Concerns	Response % and count (N = 8)	
Monetary expense	63%	5
Increased staff injury	50%	4
Decreased animal care due to time spent training	50%	4
Non-generalization of training to other staff	50%	4
Research interference	50%	4
Interference with husbandry procedures	38%	3
Increased animal stress-related behavior	38%	3
Changes in room hierarchy	25%	2
Increased human-directed aggression	25%	2
Increased animal injury	13%	1

programs (44% of NPRC's) and the short time frame most programs have been in existence. These program components can be carefully and thoroughly addressed by each facility by assessing the animal training program (see Section 5).

Even with concerns about training, there is increasing attention toward animal training programs within the greater laboratory animal community. Three of four responding facilities reported that animal training was a topic of discussion in the last 5 years during inspections and accreditation visits including: IACUC who oversee and evaluate all aspects of animal care; Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC)

Table 3

Behaviors trained at each facility (N = 9) and training methods applied.

Behavior:	Positive reinforcement	Negative reinforcement
Present rump	6	1
Present or offer arm or leg	4	0
Present face or chest	4	0
Trainer touch or manipulate	5	0
Open mouth	3	0
Blood draw	3	1
Injection	3	1
Squeeze	2	3
"Lixit"/water check	4	1
Hold for inspection or treatment	4	0
Gate/lock check	1	1
Food insertion or removal	1	1
Rump/arm injection	3	0
Stationing	5	0
Gating or shifting	7	2
To perch, floor, or intended location	6	1
Contra-aggression training for human-directed aggression	4	0
Cooperative/collaborative feeding	6	0

Table 5

Benefits of positive reinforcement training programs.

Benefits	Response % and count (N = 7)	
Increased efficiency in animal care	71%	5
Increased positive human-animal interaction	57%	4
Decreased stress-related behaviors	57%	4
Decreased human-directed aggression	57%	4
Increased staff safety	57%	4
Increased staff awareness of animal's behavior	57%	4
Increased staff communication	29%	2

International who manage a voluntary accreditation and assessment program; and United States Department of Agriculture (USDA), who inspect facilities housing animals to enforce USDA regulations, the Animal Welfare Act, and the *Guide for the Care and Use of Laboratory Animals* (2011). Two facilities reported discussions about animal training during recent Office of Laboratory Animal Welfare (OLAW) or National Institutes of Health (NIH) site visits.

5. Elements of a training program

The most effective primate training program will be one that includes clearly defined training goals, accountability, assessment and refinement of training effort, and continuing education for staff. Many of these programmatic recommendations are also described in other published papers (Colahan and Breder, 2003; Prescott et al., 2005; Young and Cipreste, 2004).

5.1. Safety

Fundamental to any animal training program is human and animal safety (Colahan and Breder, 2003; but see Young and Cipreste, 2004 for examples of safety features within a training program). People have good reason to be concerned for their safety when working with primates since they are unpredictable, strong, and capable of inflicting great harm. Depending on the species and zoonotic disease risk, personal protective equipment (PPE) such as gloves, cover clothing, a mask and eye protection may be necessary. Training can be accomplished with trainers wearing such PPE, and facility policies for PPE should always be followed while training primates. Trainers must be aware of their own positioning near the enclosure when training, and should know how far an animal can reach out, being conscious of whether social companions are nearby and may try to grab the trainer. Understanding species-typical behavior, specifically fearful behavior, can help reduce the risk of trainer-directed aggression. Safety can be enhanced through the use of engineering controls and safety apparatus such as an enclosed “blood sleeve” which allows animals to present arms or legs safely outside of the cage for conscious blood collection, while decreasing the opportunity for the primate to grab the trainer (Coleman et al., 2008). Targets are used to position primates with their hands in view or holding a peg that falls if the animal lets go; these tools enhance trainer safety when working in close proximity to primates. If food reinforcers are offered to the primate by hand, precautions to reduce the trainers risk of being bitten or grabbed need to be taken. Two examples include delivering the food at a distance using a bottle to squirt juice directly into the primate's mouth, or placing a receptacle on the cage front where food can be safely deposited by the trainer and then retrieved by the animal.

There is a need for the safety of training programs to be tested. The survey of the NPRCs showed that half of the respondents reported safety concerns at their facilities, however about half of the behavioral managers reported increased staff safety as a benefit of a training program. These conflicting perspectives highlight the need for

assessments of animal training programs with regard to personnel safety. Environmental Health and Safety offices and similar programs present in many institutions serve to address safety in the working environment. These programs may have the means to evaluate the safety of training tools and techniques used within animal training programs.

5.2. Integration of PRT into research objectives

Nearly half of the NPRC's listed that animal training was a research interference concern and 38% of respondents listed increased animal stress-related behavior as a concern. Researchers and behavioral managers can work together to establish guidelines for incorporating PRT into protocols. PRT, when applied properly, desensitizes subjects to potentially stressful elements of research procedures. At the Yerkes National Primate Research Center (YNPRC), the behavioral management scientist reviews IACUC protocols and may suggest or require incorporating PRT techniques to prepare subjects for aspects of the study (McMillan et al., 2007).

In a research setting, time constraints can influence what training is accomplished. Researchers usually do not budget for subject costs in advance of beginning study procedures, but this may be necessary to have the time to train subjects to cooperate with study procedures. A greater commitment to PRT requires considering costs and logistics associated with pre-study animal arrangements, such as acquiring animals ahead of the onset of the study, initiating training while animals are in quarantine, and ensuring appropriate staff expertise. In some cases vendors may be able to provide primates that have received some level of training or conditioning which may then expedite the animal training process for specific research procedures. All should be considered when planning research studies and writing grant proposals to support research.

The selection of subjects for some studies may be aided with the involvement of behavioral management staff members. At the Oregon NPRC, monkey temperament characteristics have been useful in identifying animals who are more responsive to PRT than others, and thus may be more suitable subjects for particular studies (Coleman et al., 2005). At the California NPRC the animal record keeping system indicates if an animal is trained or in the process of being trained for a behavior. The Behavioral Management group can be contacted to get specific information about the training.

5.3. Continuing education

There are many opportunities available to those in the laboratory animal community to broaden animal training knowledge. There are numerous books, articles, internet discussion forums, and websites on animal training (see Laule and Whittaker, 2001; see also Prescott et al., 2005; Pryor, 2002; Ramirez, 1999). Workshops such as the “Primate Training and Enrichment Workshop” (<http://ptew.kccmr.org/>) are available and conferences, including International Marine Animal Trainers' Association (IMATA) (<http://www.imata.org>)

and the Animal Behavior Management Alliance (ABMA) (<http://www.theabma.org/>), focus mostly on training. Animal training consultants can be useful resources. Additional continuing education opportunities that can be supported within the institution include journal clubs, interest groups, an animal training committee, and lectures to hear invited speakers with expertise in behavior management and animal training. If the primate laboratory employs an animal training specialist, this person can conduct PRT workshops, lectures, and practical learning opportunities for individuals working with nonhuman primates. The [Joint Working Group on Refinement \(2009\)](#) recommends learning outcomes for staff training of familiarity with behavior and how to interact with the relevant species in a positive way.

5.4. Documentation and record keeping

Documentation is an important component of formalized training programs ([Prescott et al., 2005](#); [Young and Cipreste, 2004](#)). Communication of institutional or programmatic training goals, training applications and expectations, and providing opportunities for consistency and communication among trainers and staff who will be maintaining any trained behaviors are vital in the success of a training program. In general there should be some record of: (a) which animals have been taught what behaviors; (b) the approach used for their training; (c) the cues used; (d) the animal's expected behavioral response to the cue; and (e) some measure of the animal's consistency in responding.

Shaping plans, established training protocols, and training documentation sheets are used to record and review training progress. Training documentation sheets should include data such as number and duration of sessions, shaping plan steps trained during a session, and the animal's response. These data assists trainers in summarizing training progress and identifying problems. Training documentation improves communication, which is especially important if multiple trainers work with an individual animal.

5.5. Encouraging consistency and transfer of trained behaviors

Most primates in laboratories work with several people on a daily basis, and they are often trained by multiple people. Documentation of universal cues and expected responses can help increase training consistency across multiple individuals. For each behavior there should be the verbal cue, photograph and description of the corresponding visual cue (see [Fig. 2a](#)) and a photograph and description of the animals expected behavioral response (see [Fig. 2b](#)). If all animals are trained using the same cues and all trainers train a behavior to look a specific way, inconsistency is minimized. For example, see [Minier et al. \(2011\)](#) for an assessment of PRT progress using single and multiple trainers to reduce human-directed aggression.

There is often concern over whether primates trained by one individual will perform the same behavior for others, and dealing with this “transfer” of trained behaviors

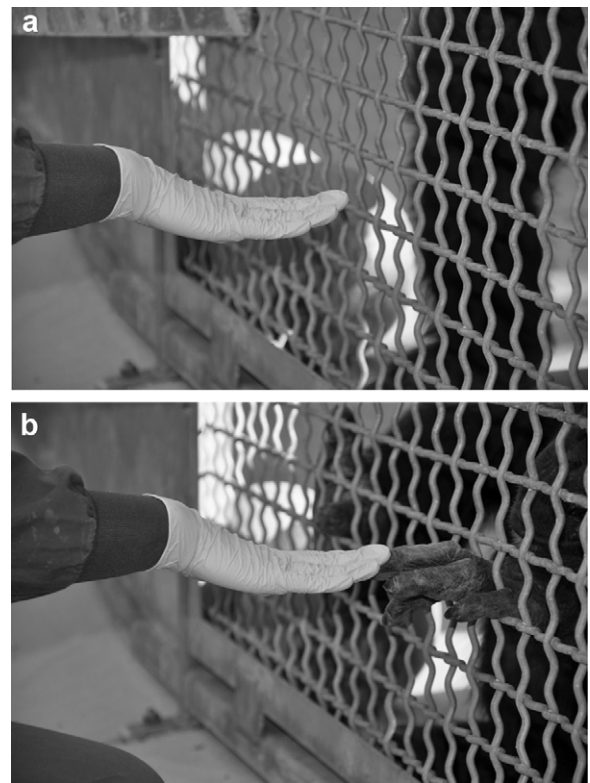


Fig. 2. (a) and (b) shows the “hand” behavior. The trainee presents left hand. (a) Universal cue: verbal cue; “Hand”. Corresponding visual cue; trainer's right hand held flat with fingers and palm parallel to floor. Hand remains 3–5 cm from the mesh. (b) Expected response: trainee's fingers through the mesh in front of trainer's hand in a straight relaxed position allowing trainer to gently touch the top of trainee's hand.

between trainers is important. In one model, the primary trainer is responsible for initial training, following a shaping plan and documenting training sessions. Once the primate is performing the behavior reliably (e.g., four out of five times asked) the behavior is considered trained. At this point, the trained behavior may be transferred from the primary trainer to the secondary trainer who will then be responsible for maintaining the behavior at the same criterion. At least one study has shown that primates' performance can be sustained through this transfer process ([Bloomsmith et al., 1998](#)). Not everyone will become a good primary trainer, but everyone working with primates should learn the basic principles of animal training and apply them effectively to maintain trained behaviors.

5.6. Evaluation of training program

The evaluation of animal training programs is recommended to assess whether the program is meeting the needs of the animals, and set goals for husbandry, veterinary care, and research. Individuals implementing the training should also be assessed regularly for technique, consistency and progress. Regular meetings among staff who are planning and implementing the training are

encouraged so progress can be highlighted, and challenges can be discussed and addressed.

6. Identifying and minimizing negative reinforcement training (NRT) methods

NRT is widely used in primate facilities (NPRC survey described above; [Prescott and Buchanan-Smith, 2007](#)) and its use needs to be thoughtfully addressed. Common types of NRT include:

1. using the squeeze back to move an animal to the cage front for an injection or treatment;
2. loud voices, clapping or tapping on the cage, threatening with a net or leather gloves to move an animal from one location to another;
3. a person entering an enclosure to get an animal to move away from that person and into a transport box or tunnel;
4. spraying water behind an animal to encourage movement from one location to another; and
5. threatening with a dart gun to get an animal to present for an injection.

Often people using these techniques do not recognize them as negative reinforcement, but this recognition is an important step in trying to minimize its use.

To date there is no published literature comparing PRT and NRT techniques on the behavior or well-being of primates, but there is some literature on other species. Differences have been found in equine behavior and physiology based on training techniques employed. Horses trained with PRT exhibited more exploratory behavior and participated more in training sessions than those trained with NRT. A higher heart rate in the PRT group in the later stages of training was considered a positive physiological response linked to increased motivation to participate and anticipation of food rewards ([Innes and McBride, 2008](#)). Comparing horses trained only with NRT to those trained with a blended approach of NRT followed by PRT showed those in the latter group expressed behaviors and body postures indicating improved welfare ([Warren-Smith and McGreevy, 2007](#)). Given the widespread application of NRT in primate facilities similar assessments should be conducted with nonhuman primates to understand the impact on welfare measures.

There are significant challenges to moving from a NRT-based system toward a more PRT-based program for laboratory primates. The large numbers of animals to provide PRT to, limitations due to research protocols, and rigid schedules and feeding times may make a move toward a more PRT-based program difficult. Rotating staff, staff turnover or resistance to a new system may further complicate the process of moving to a more PRT-based program. Of significant importance is the fact that the effective use of PRT is a skill that takes time and effort to develop. However, given the known benefits of PRT, we suggest that modern laboratory primate training programs should have the objective of using as little NRT as possible, moving toward eliminating its use and replacing it with positive reinforcement.

When PRT is not currently practical as the sole approach to all needed animal training, careful consideration should be given to how a combination of PRT and NRT might be implemented. Even in a system that will use NRT, animals should first be given the chance to cooperate before any aversive stimulus is presented and all staff should use clear and consistent cues. If it is necessary to use the aversive stimulus, the mildest negative reinforcement that is effective for an individual animal should be applied. For example, to move an animal to the front of a cage, instead of bringing the squeeze back wall all the way forward as the first step, begin by tapping on the latches that release the squeeze. If the subject does not respond, unlatch the latches. If still no response, move the squeeze wall a small way toward the subject, and so on. When the animal does the correct behavior, immediately provide a reward, and remove the aversive stimulus. The animal may not accept the reward when they are uncomfortable or feel threatened, but trainers should continue to offer it. Over time, the animal may become more comfortable, and take the food reward. Patience needs to be exercised as the primates learn to live in a new system.

Other steps toward emphasizing PRT include planning ahead and preparing animals in advance of veterinary procedures and research protocols by training individuals to cooperate with some or all aspects of these procedures. Even if animals can only be trained to cooperate with some components of a procedure (e.g., blood collection from the earlobe can begin with rewarding the subject for approaching the front of the cage and presenting the ear; subjects can be desensitized to the equipment used, such as needles and alcohol swabs), this is better than using no training at all.

Another step in minimizing NRT and emphasizing PRT is to start with small projects that have a high chance of success. This helps staff develop confidence and demonstrates the efficacy of PRT. Some important steps to take to make this shift include:

1. Identify staff roles and responsibilities by determining who will be the primary trainers responsible for training new behaviors from start to finish.
2. Determine what tools and equipment are necessary to complete training tasks, and acquire them.
3. While it may not be possible to exclusively use PRT, every effort should be made to move in that direction. As a working principle, positive alternatives should be exhausted before any kind of NRT is employed.
4. When NRT is necessary, it should be kept to a minimum and balanced by delivering positive reinforcement the majority of the time.

When moving away from a NRT-based system to a more PRT-based system, two important steps are to determine the current status of training practices, and to assess the interactions between primates and humans working with them. The following questions should be answered:

1. How are animals moved between enclosures, into transfer boxes, etc.? Does this process use NRT, PRT, a combination, or are inconsistent approaches used?
2. How do animals respond to daily husbandry practices? Are they cooperative, fearful, or is their response staff-dependent?
3. What types of restrictions exist for the animals on the study protocols? Are the animals on a restricted food and/or liquid diet? Is there more than one laboratory working with the same animals?
4. What animal behavior problems exist for husbandry, veterinary, and research staff? Are animals non-cooperative, aggressive or fearful?
5. With what frequency and intensity do the above problems occur?

Finally, assess the daily, weekly, and as-needed interactions between an animal and various staff members (husbandry, veterinary, and research). When this information is compiled, the results can be surprising. Often staff may think PRT is used because a treat is provided to the animal following a procedure. However upon further investigation, one learns that the animal 'cooperates' to avoid something (net, squeeze back, etc.) rather than just to earn the treat. Conducting observations of practices may reveal undesirable or abnormal behaviors exhibited by the animals around the time of these procedures. A thorough assessment of current practices will provide a good platform upon which to begin the development of a PRT-based management system.

7. Yerkes National Primate Research Center's approach

As an example of one primate institution's approach to developing an animal training program, the evolution of the program at the Yerkes National Primate Research Center (YNPRC) will be described. YNPRC houses nearly 3400 nonhuman primates in two locations in a variety of settings from groups living in corrals and runs, to individuals living in pairs and singly in cages. These animals are used in the Center's research studies on topics such as cognition and behavior, vaccine development and disease progression. The Division of Animal Resources is responsible for the care and well-being of the nonhuman primates and numerous principal investigators and laboratory personnel conduct the behavioral and biomedical research.

Prior to 2005, Yerkes had accomplished animal training through numerous project-based approaches, often driven by research laboratories to meet research objectives, and through section-wide approaches (e.g., the chimpanzee section began doing some training with most of the animals). A training consultant was used in some situations. The result was training success for a limited number of animals, but with little consistency in training methods among people in the various laboratories or across the many animal housing areas. This approach had weaknesses. For example, a chimpanzee may have been trained to cooperate with an injection by research personnel, but the behavior was not always transferred to veterinary staff so that they could successfully inject that same chimpanzee

by voluntary means. Because trainers were working independently, there was no consistency or communication regarding the cues used for training specific behaviors, no centralized documentation of training progress, and no way to track what behaviors a certain primate had learned.

In 2005, Yerkes adopted a facility-wide approach. Efforts to raise the program to this level included hiring a full-time primate training specialist (PTS), establishing an animal training committee, and setting training goals that included all species of primates housed at Yerkes, and included primates who live in indoor cages, as well as those housed in small and large groups. The animal training program originates in the Behavioral Management Unit. The PTS is jointly supervised by the Behavior Management and Animal Care Units, which emphasizes the importance of training to both units. The position is a resource to all Yerkes departments that use primates. This position requires an animal training background, familiarity with operant conditioning theory and practice, strong problem solving skills, and strong interpersonal communication skills. The success of a training program relies heavily on selecting an individual with a calm demeanor, patience, consistency, and an ability to analyze one's own behavior (Prescott et al., 2005; Young and Cipreste, 2004).

The PTS trains people much more often than she trains nonhuman primates, and this is an important element in a large primate facility, since one person would only be able to work with a small fraction of the animals that should be trained. The PTS responsibilities include educating staff and faculty about the Yerkes' animal training program, teaching operant conditioning terminology and techniques through seminars and hands-on instruction, serving as an internal consultant to assist in developing animal training plans, and assessing progress on training goals. Some training consultations between the PTS and principle investigators conducting research are recommended through the IACUC protocol review process. Depending on the need, the consultation may entail a review of existing animal training plans, recommendations for incorporating specific training methods, and discussion about how the study or study subjects could benefit from animal training.

Another component to the training program is the Animal Training Committee comprised of people from Behavioral Management, Veterinary Medicine, Animal Care, Colony Management, Occupational Health and Safety, and research laboratories. This inclusive, team approach is consistent with recommendations by others (Prescott et al., 2005; Prescott and Buchanan-Smith, 2007). The Animal Training Committee has been responsible for developing these major advances:

- (1) Establishing training goals for the entire Center. Drawing on the broad composition and training needs of committee members, three training goals that impact the majority of departments working directly with the primates were established: movement of animals, present for injection and conscious blood collection.
- (2) Developing an institutional training philosophy (see Fig. 3). This serves to communicate to the Yerkes community a rationale for, and expectations of the animal

Yerkes National Primate Research Center, Animal Training Philosophy

Training is an animal management tool that facilitates good animal care by promoting animal socialization, enhancing cognitive stimulation, and decreasing stress. Training also facilitates the conduct of research protocols and facilitates veterinary care of animals. The philosophy of the animal training program at Yerkes is to enhance the well-being of monkeys and apes by maximizing the use of positive reinforcement training. Other training methods are also appropriately used in some situations.

There are a number of elements to consider as Yerkes personnel work to achieve our training goal.

1. Safety comes first in any training program, including the safety of the animals and the trainers. We use equipment and procedures geared toward enhancing safety.
2. Educating employees is critical. This includes making sure they understand the correct uses of positive reinforcement training and the acceptable application and context in which negative reinforcement may be used. Negative reinforcement should be followed with positive reinforcement when possible. Staff members involved in training are expected to understand the goals of the program, training terminology and the appropriate use of positive and negative reinforcement methods.
3. Good record keeping is part of a successful training program. This includes written “shaping plans” for all behaviors, and documentation that tracks of training sessions. The center’s Primate Training Specialist routinely will review and evaluate training documentation.
4. Evaluation of the training program also will include a quantitative assessment of data (some collected through the documentation system) that will help answer specific questions about the value of training. As appropriate, some of these evaluation projects will be published.
5. To achieve a “facility-wide” training program we will increase training consistency across Yerkes by offering training classes, using consistent “shaping plans” and employing a centralized documentation system. Success will be noted when animals trained for certain behaviors successfully perform those behaviors for each appropriate staff member.

Fig. 3. Yerkes National Primate Research Center Animal Training Philosophy.

training program, and the commitment of the Center to enhancing care for nonhuman primates.

- (3) Determining the basic training information provided to all new employees working with primates (included in orientation packets). All staff members are informed of the scope, function, availability and services of the animal training program.
- (4) Developing a plan to identify staff members that need to understand training. The “All Staff Training Plan” was developed to educate all faculty and staff working with primates about animal training, the services provided by the PTS, and goals of the animal training program. The Director of Yerkes strongly encouraged principal investigators, veterinarians, supervisors, and laboratory managers to be involved. This level of commitment and dedication from the very top of the administration was integral in the promotion and continued support of the animal training program.

Results of this comprehensive training program are many. With a core group of Animal Care staff familiar with training, daily training for husbandry can be implemented (McMillan et al., 2007). Husbandry training objectives include training primates to voluntarily enter transport boxes and to shift between areas within home enclosures (McMillan et al., 2009; Veeder et al., 2009). The majority of the PTS’s consultations with research laboratories have focused on pole and collar training, chair restraint training (McMillan et al., 2010), and biological specimen collection (e.g., blood, urine, semen) (Perlman et al., 2010). Other behaviors and animal management issues addressed have included present for injection, desensitization to fear-provoking stimuli (Clay et al., 2009), training to decrease

human-directed aggression (Martin et al., 2011), improving research testing performance, training to decrease abnormal behavior (Baker et al., 2010), and training to enhance socialization. The facility-wide approach has enhanced communication and function between those in various departments working with the same primates.

8. Summary

This paper presents a framework for categorizing the structure of animal training programs for both existing and planned programs. The program structure should be developed around the animal care needs and the goals of the facility. A structure that works for one facility may not be a good fit for another. Assessments of PRT on husbandry (e.g., moving animals), behavior problems (e.g., fear, self injury, undesirable behavior), and veterinary and experimental procedures (e.g., present for injection and blood collection) shows that animals trained with PRT have enhanced welfare. Currently, about half of the NPRCs in the United States of America have formalized animal training programs, and the others are in various stages of creating animal training programs. It is recommended that more primate facilities develop formalized animal training programs emphasizing PRT to continue to meet and exceed regulatory requirements and to improve the welfare of their animals.

Conflicts of interest

The author and co-authors of this manuscript have no conflict of interest, real or perceived

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.applanim.2011.11.003](https://doi.org/10.1016/j.applanim.2011.11.003).

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