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Positive Reinforcement Methods to Train Chimpanzees to Cooperate with Urine Collection

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Positive reinforcement training can be used in many ways to enhance the welfare of captive primates. Training for biologic sample collection is one application of positive reinforcement training. In this study, 35 adult female chimpanzees were trained to cooperate with the collection of urine samples needed to facilitate a research study. A median of 35 training sessions was required for the subjects to reach reliable performance (4 of 5 sequential attempts successful) of the urine collection behavior. Adult age had no effect on the speed of learning as indicated by a rank order correlation. Individual differences in the rate of learning were pronounced but did not vary with the age of the chimpanzees. Approximately 2 y after the initial training, and with continual sample collection taking place twice weekly, we assessed the reliability of their performance and found that the chimpanzees cooperated 100% of the time and that collection of a urine sample required about 5 min. Positive reinforcement training can markedly reduce staff time, particularly for studies such as this that require frequent biologic sample collection over long durations. Similar approaches could be used to train other laboratory primates to cooperate with urine collection procedures. Animal training programs that emphasize positive reinforcement training are an important refinement in the care of laboratory primates.

During the past 2 decades, there has been growing interest in using positive reinforcement training techniques in diverse ways to enhance the welfare of captive primates. Positive reinforcement training has been used to train primates to voluntarily participate in husbandry procedures,[12,13,15] veterinary procedures,[7,9,10] and research procedures.[3,4,5] Positive reinforcement training has also been shown to improve the social dynamics in primate social groups[2] and, in some cases, to reduce abnormal behavior patterns.[3] Positive reinforcement training increases voluntary cooperation, reduces fear, engages the animals' ability to learn, and increases their control over their environments.[8] In some situations, this training may be a more efficient use of personnel time, requiring less time than traditional techniques to complete certain procedures.[11,15] The time savings may be particularly noteworthy for studies that require biologic sample collection frequently or repeated sample collection over long study durations.[10]

Positive reinforcement training is a type of operant conditioning in which the trainer teaches the animal to cooperate by rewarding the animal after it demonstrates the desired behavior. A fundamental principle of operant conditioning is that behavior is influenced by its consequences. If an animal is rewarded (given something the animal 'wants') after it performs a specific, targeted behavior, the animal is more likely to perform that behavior again. Under this paradigm, the animal is not coerced in any way but can choose to participate or not. Operant conditioning techniques, along with the classical conditioning technique of systematic desensitization, have been used to teach animals to cooperate with certain procedures in a research setting. One application of positive reinforcement techniques has been to train cooperation with the collection of biologic samples such as blood, saliva, feces, semen, and urine.[8-10,14] Urine samples assist in the veterinary care of individual primates (for example, to detect abnormalities associated with infection or glycemic control), in managing a population of primates (for example, testing urine samples to determine if females are pregnant), and in conducting research with the animals (for example, to measure urinary hormone levels).[6] Because urine sometimes is used in studies with stress-sensitive measures, the validity of that research may be improved by using a method of sample collection that is noninvasive and that is based on voluntary cooperation of the subjects, because this approach likely will minimize stress associated with the collection method. Urine collection may be superior to blood sampling in which the pain associated with a needle stick, although brief, is unavoidable. The 3 published reports of urine collection training with nonhuman primates both included trainers going inside the animals' enclosure,[7,10,14] which is not feasible or safe with all species or in all circumstances. Another publication describes an apparatus that attaches to an enclosure and includes multiple small units for brief individual housing for feeding and urine collection and describes the animal training involved in its use.[1]

The purpose of the current study was to assess the time required to train female chimpanzees (*Pan troglodytes*) to cooperate with a simple biologic sample research procedure when the trainer remained outside the enclosure and to evaluate how the time required to train varied according to the age of the subjects. Only positive reinforcement training methods were used. We describe the training methods and the number of training sessions required for the subjects to reach a performance criterion, test for possible age-associated differences in learning speed, and evaluate the reliability of the training over time. This practical information may guide others in conducting this type of training with chimpanzees or other laboratory primates and in planning for the resources (for example, time, personnel) required to incorporate a similar approach in their own research projects.

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Materials and Methods

Subjects. Subjects were 35 adult female chimpanzees that ranged in age from 9 to 49 y when the training began. The subjects were fairly balanced across age categories representing young (9 through 13 y), middle-aged (14 through 28 y), and older (30 through 49 y) adults. The subjects lived in social groups with 2 to 6 members in indoor–outdoor run-type housing at the Yerkes National Primate Research Center (Atlanta, GA). All had some previous exposure to positive reinforcement training and to the use of a 'clicker' (described later).

Equipment. The urine-collection device was designed so that it would be safe in the event chimpanzees took one into their enclosures. The urine collection device was a piece of schedule-40 PVC pipe that was 0.75 in. in diameter and was fitted with an elbow joint on one end. Most devices were about 3 feet long, but the length of the device varied based on the distance needed to reach the subject when she was in position for collection.

Training approach. Because only positive reinforcement techniques were used, the chimpanzees' participation in the training sessions was always voluntary. A clicker (a handheld device that produces a sound when pressed) served as a secondary reinforcer, to indicate to the animal that she is doing the desired behavior. The first basic step of the training approach was to 'capture' spontaneous urination by giving the chimpanzee a large food reward (such as a whole piece of fruit) after any observed urination. When the subject urinated, the trainer would give the verbal cue ("pee") and sound the clicker so that she could begin to associate the cue with the behavior of urinating. In some cases, the chimpanzees were given a large amount to drink or were worked with early in the morning, to facilitate the likelihood of urination. The next step was to train the chimpanzee to move into a desired position within her enclosure that would allow for easy collection (either hanging on the front of the enclosure with her arms extended or sitting on a stationary resting platform or on a plastic enrichment barrel) by using a verbal cue and to shape her behavior by continuous reinforcement as she made small steps of progress closer to the desired position.

The third step of the training approach was to introduce the chimpanzee to the urine-collection device. Counter-conditioning techniques (processes of actively pairing something positive with an aversive stimulus until the stimulus loses its ability to adversely influence behavior, so that the aversive stimulus becomes more neutral over time) were incorporated when a subject's behavior indicated fear of the device (for example, moving away from it). Subjects were rewarded for remaining in position and for not interfering with the device. These three steps in the training process then were combined by calling the chimpanzee into the proper position, placing the collection device under her, giving the verbal cue to urinate, and providing rewards (food, juice and verbal reinforcement) once urination began. In the final step of the training process, subjects were differentially rewarded for urinating quickly after the verbal cue, by giving a larger reward for a more rapid response.

Training sessions were conducted 2 to 5 times each week. During most sessions, the subjects' groupmates were all together; in other sessions, a subset of the group or just the individual subject was segregated for the brief training session. Some chimpanzees were segregated due to their participation in a related study that precluded their observation of the training process of others, and some were removed from a groupmate that persistently tried to take the urine-collection device from the trainer. Dominance status was not a factor in determining which chimpanzees were trained together and which were with their groupmates during training sessions.

Three experienced trainers worked with the chimpanzees. They followed the same general training plan, met regularly to discuss the training, and were assigned animals so that each chimpanzee was trained by a single trainer. Initial training was conducted at the same location (either inside or outside portions) of the subjects' enclosures whenever possible, and once the chimpanzees met the training criterion, the trainer began to vary the locations where the samples were collected. Training sessions occurred during all periods of the day, even alongside other activities and events in the area (for example, husbandry procedures, other research events, maintenance and construction).

For the purposes of the study for which the samples were being collected, once the chimpanzees were trained, 2 urine samples were collected weekly while they were in their social groups or, in a few cases, with a subset of their group members. A chimpanzee was considered fully trained or 'reliable' once she urinated on cue and in such a way that the trainer could collect the sample, in 4 of 5 consecutive training sessions. At some point after subjects reached reliability, the urine-collection process was transferred to one of the other trainers, so that samples could be collected even if the primary trainer was not available. This transfer process involved additional communication between the 2 trainers regarding the particular chimpanzee's typical response to the training, the secondary trainer's observation of a training session conducted by the chimpanzee's primary trainer, and the primary trainer's observation of the secondary trainer's first session with the chimpanzee. The goal of the transfer process was to increase consistency between the 2 trainers and thus to increase the likelihood of the subject continuing to cooperate.

The most common training problems encountered were chimpanzees grabbing at the urine collection device (either the study subjects or their group mates) and the subjects urinating in a location in the enclosure that would not allow the collection of the urine sample (that is, too far away from the trainer for the collection device to reach the chimpanzee). When a subject grabbed at the device, we used the verbal cue 'leave it' and rewarded subjects for not interfering with the device. Occasionally a chimpanzee grabbed the collection device and pulled it into her enclosure, but in these situations, the device typically was retrieved by trading it for a preferred food item, and no injuries occurred. If a subject repeatedly urinated while she was in a location that did not allow urine collection, we provided additional training for moving to and staying in the correct location.

Documentation. After each training session, the trainer recorded the day and time of the session, and the animal's performance was described by using a 5-point rating scale: 1, chimpanzee climbs on cage front or onto the resting shelf or barrel, with hands positioned safely; 2, chimpanzee stays in position and tolerates the collection device held outside and parallel to the enclosure; 3, animal stays in position and tolerates device held outside and perpendicular to the enclosure; 4, chimpanzee stays in position and allows device to be positioned beneath her; and 5, animal urinates into device on cue. Documentation continued even after the chimpanzees were deemed reliable and as urine samples were collected routinely.

Data analysis. The total number of training sessions required for each subject to reach reliable performance (sample collected in 4 of 5 consecutive sessions) was analyzed by using Spearman ρ correlation between the number of training sessions and subject age. The statistical software SPSS (IBM, Armounk, NY) was used.

Results

A median of 35 training sessions was required for the subjects to reach a reliable performance of the urine collection behavior.

Adult age had no effect on the speed of learning, as indicated by rank-order correlation (Spearman ρ = 0.16; $P = 0.35$; Figure 1). Descriptively, we divided subjects into age categories and found that the young adults (9 through 13 y) were trained in a median of 41sessions, middle-aged adults (14 through 28 y) in a median of 31 sessions, and older adults (30 through 49 y) in a median of 41 sessions.

The rate at which individual chimpanzees acquired this behavior differed markedly and ranged from 8 to 232 training sessions. Age did not seem to affect interindividual variability. Young adults required 8 to 149 sessions, middle-aged adults 10 to 232 sessions, and older adults 16 to 171 sessions.

The total duration of training time required to teach this behavior was difficult to determine because the training sessions included working with multiple animals from the same group, working on multiple behaviors to be trained, and, in some cases, training sessions were lengthened to allow the opportunistic collection of a sample in a subject who was not yet trained fully.

During the course of the project, 3 fully trained subjects underwent periods of substantial regression in their performance. This regression sometimes could be attributed to the movement of groups to new locations or to changes in social group membership. In each case, additional training with the subject was conducted until her performance again met the reliability criterion.

To assess the chimpanzees' performance on this behavior over a long period of time, we assessed their performance during the latest 10 attempts to collect urine, which were about 2 y after the initial training (2 urine samples were collected weekly during most of that 2-y period). All 35 subjects complied during 100% of these most recent attempts. The mean duration of time for the trainer to collect these urine samples was 4.9 min (range, 1 to 30.7 min). Eight of the 35 subjects always provided a urine sample within 1 min.

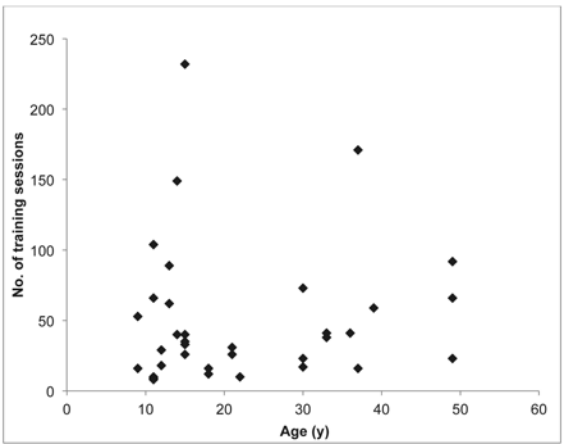

Figure 1. Scatterplot illustrating the lack of relationship between subject age and the number of training sessions required to meet reliable performance.

Discussion

Positive reinforcement techniques were applied successfully to train 35 adult female chimpanzees to cooperate with voluntary urine collection in a median of 35 training sessions each. Subject age was not statistically related to the number of training sessions required to reach reliable performance. Individual differences in the rate of learning were pronounced but did not depend on the age of the chimpanzee. Approximately 2 y after the initial training, we assessed the reliability of their performance and found that they cooperated 100% of the time and that it required about 5 min to collect a urine sample. This procedure is much more efficient than is the traditional method of collecting urine samples from chimpanzees by separating a chimpanzee from her group, moving her into a transport cage with a removable pan or into separate quarters with a clean floor from which a urine sample can be collected with a syringe, giving her liquids, and waiting for her to urinate, and then returning her to her group.

Similar to the success we obtained in this project, others have trained vervet monkeys[7] and New World monkey species[14] for urine collection, although they used other approaches. For example, one group of colleagues[14] found that 2.5 to 4 h of positive reinforcement training sessions were effective in increasing the number of urine samples collected, increasing the proportion of monkeys that urinated, and increasing the speed at which samples were provided. In that study,[14] the animals were trained as a group and any that urinated were reinforced; the animals were not trained to urinate into a receptacle, but instead the trainers entered the animal enclosure after the urination to collect the sample off of a surface. One published study described the urine collection training for a young, nursery-reared chimpanzee which included the trainer entering her enclosure.[10] Clearly positive reinforcement can be used in multiple ways to train primates to urinate for sample collection.

Having an estimate of the number of training sessions required to achieve reliable performance facilitates advanced planning for training needs for particular research studies or other needs. Because training requires designated personnel time, having estimates of the required time facilitates projections regarding the monetary support needed for the training effort. In some cases, this support can be included in grant proposals for the research projects involved. The current study involved chimpanzees, but the animal training principles applied are comprehensive, so similar approaches could be used to train other laboratory primates and other species to cooperate with urine collection procedures. We note that due to the large interindividual variation in the rate at which subjects learned this task, predicting how quickly an individual chimpanzee will be trained may be difficult. Examination of subject characteristics that indicate such variation (such as temperament[5]) likely will be helpful in being able to more precisely predict the training performance of individual animals.

Animal training programs that emphasize positive reinforcement training are an important refinement in the care of laboratory primates,[10,11,12,13] because they can help to reduce stress experienced by animals. Furthermore, these methods improve the research by reducing this potential confound. Personnel qualified to conduct the animal training and sufficient time for training should be included in planning for future studies. The current study is an example of how we can address the welfare of laboratory primates as we meet the research objectives of biomedical research studies.

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