Using Operant Conditioning and Desensitization to Facilitate Veterinary Care with Captive Reptiles

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KEYWORDS

• Reptile • Training • Operant conditioning • Desensitization

KEY POINTS

- In addition to being a large component of most zoological collections, reptile species are also becoming more and more popular as family pets.
- Reptiles have the cognitive ability to be trained in order to facilitate daily husbandry and veterinary care. Desensitization and operant conditioning can alleviate some of the behavioral and physiological challenges of treating these species.
- A survey of reptile training programs at zoos in the United States and worldwide reveals that there are many successful training programs being used in zoological settings to facilitate veterinary care and minimize stress to the animal.
- Many of the techniques being used to train reptiles in zoological settings are transferable to the exotic pet clinician. These techniques are useful for improving veterinary care in private herpetological collections and for the family pet.

INTRODUCTION

Many reptile species have become increasingly popular as pets. Exotic animal veterinarians are well aware of the impact that stress can have on their patients, and how that stress can impact both the quality of the examination and overall health of the animal. Utilizing operant conditioning techniques during veterinary procedures can decrease the stress associated with the visit and increase the effectiveness of the procedures. This article examines how different training and conditioning techniques

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can facilitate improved veterinary care and management of reptiles in the home, at the exotic animal clinic, and in zoological settings.

REPTILE HEALTH—DISEASES, DIAGNOSTICS, AND THERAPIES

Common Diseases Seen in Reptiles

Captive reptiles can develop a variety of illnesses, ranging from infectious to neoplastic to husbandry-related. As with any species, a complete history and physical examination, with appropriate diagnostic testing, are essential to accurately diagnosing and treating the animal. A challenge with many exotic species is to understand and minimize stressors that can affect behaviors and physiologic parameters in order to obtain the most accurate diagnosis. This section will review common diseases of reptiles, examination and diagnostic testing, and how the stress during veterinary procedures can affect interpretation and treatment of animal illnesses.

The exotic practitioner very commonly encounters husbandry-related illnesses in reptiles, many of which are related to the precise environmental parameters (eg, temperature, humidity, ultraviolet exposure, substrate) and diet that these species require. Common husbandry-related problems seen in reptiles include dysecdysis, metabolic bone disease, obesity, vitamin deficiencies, traumatic abscesses, and stomatitis. A thorough examination of any reptile must require a complete investigation of its housing and diet, both current and historical, to detect or rule out husbandry-related disease.

Infectious diseases are also frequently encountered in captive reptile species, both in pets and in zoological collections. Of the infectious diseases, endo- and ectoparasite infections can be simplest to diagnose, requiring a positive identification from a fecal sample or skin sample, though other parasitic infections can necessitate more extensive testing (eg, radiographs or gastric biopsy). Bacterial, viral, or fungal infections can be slightly more challenging to diagnose; and usually require more extensive testing, including oral, nasal, or cloacal swabbing for polymerase chain reaction or culture, blood collection for culture, or serologies for identification of the etiologic agent.[1]

Finally, in addition to the reptile-specific husbandry and pathogen-related diseases, captive reptiles experience degenerative, metabolic, traumatic, or neoplastic diseases just as do nonreptile species. A thorough diagnostic examination must investigate all likely causes of disease.

Effects of Stress in Evaluating Animal Health

Reptiles can react to psychological or physical stress in ways that make it difficult to interpret behavior, examination findings, or laboratory values. Creating a less stressful environment is important for observing natural behaviors such as ambulation, head and eye movements, and response to stimuli. Stressed reptiles may display false symptoms of illness such as erratic behavior or feigning death, particularly seen in hognose snakes (*Heterodon* spp), and increased respiration rates have been seen in response to elevated corticosterone levels in western fence lizards (*Sceloporus occidentalis*).[2]

The physiological and physical stress that may occur during an examination can affect diagnostic results and potentially harm the animal. Studies have shown that exogenous administration of corticosteroids can cause hyperglycemia in certain lizard and snake species.[3–5] Decreased cholesterol content of liver, increased urea content of liver and kidney, and increased activity of glucose-6-phosphatase in the liver and kidney has been noted in lizards following corticosteroid administration.[4] However, the response to exogenous corticosteroids, and the production of endogenous steroids, can be seasonal for some species.[6,7] Exhaustive activity in laboratory crocodilians resulted in a significant decrease in blood pH and a significant increase in blood lactate levels,[8,9]

suggesting that forceful restraint in an examination may alter blood chemistry. Interestingly, a study in painted turtles showed that when put in situations of forced anoxia, glucose and lactate levels rose; however, during recovery corticosterone levels rose as lactate fell, suggesting that steroids may play a role in lactate metabolism and clearance.[9] Additionally, handling alone can cause increased corticosterone levels which in turn can cause increased energy demands in already compromised patients.[10,11] Forceful restraint can lead to trauma (eg, fractures in an animal with metabolic bone disease or osteomyelitis) and some herpetofauna will drop their tails in response to stressful handling. Due to the physiologic and physical responses to stress, desensitizing captive reptiles to handling can be important in developing an ability to perform a successful examination, obtaining accurate diagnostics, and preventing injury to the animals.

The Reptile Examination

To minimize stress during the examination, the room or enclosure should be an appropriate temperature for the species in order to observe the animal's behaviors as normally as possible. External stimuli should be minimized, and if possible, species-specific items may be used to help the animal feel more comfortable (eg, chameleons may prefer to have a branch to hold on to during the examination).

The most important diagnostics in any reptile examination are a thorough history and a complete physical examination. History must include information on husbandry (substrate, lighting, humidity, temperature gradient), diet, exposure to other animals, where and when it was obtained by the owner, behavior, appetite, fecal and urate production, weight, and any other pertinent information related to the cause of the veterinary visit. Prior to handling the animal, practitioners should attempt to observe its activity, appropriateness, and ambulation. Latex gloves must be worn during the physical examination, and experienced handlers should be employed to ensure the animal is comfortable and thus maximize the diagnostic value of the exam. Most pet reptiles can be examined under manual restraint alone. However, some species or individuals may require additional restraint devices (such as tubes, poles, boxes, or protective gloves) or techniques (such as placing visual barriers or employing the vasovagal response) in order to minimize movement during the examination. Procedures usually performed in awake reptiles include blood samples for hematology, blood chemistry, and blood culture; fecal samples; oral, nasal, or cloacal swabs; aspirates; radiographs; and ultrasound. Diagnostics that require anesthesia include rigid or flexible endoscopy, advanced diagnostic imaging, and surgery.

Therapies and Monitoring

It is important to ensure that thorough records, including regular weight, feeding, and husbandry information, are maintained. The owner or keeper must be able to assess the animal's behavior, condition, and any physical abnormalities to note any changes. Correcting husbandry concerns is a top priority for treating both husbandry- and non–husbandry-related illness in reptiles. Sick reptiles should be kept at the high end of their temperature gradient in order to increase their metabolic rate and support the immune system. Humidity must also be carefully controlled depending on the disease—for example, high humidity may benefit animals undergoing dysecdysis, but may predispose an already compromised animal to secondary fungal infections. Diet adjustments may need to be made including offering different types of prey, or sometimes syringe or tube feeding or placing an esophageal feeding tube.

Systemic medications can be administered enterally or parenterally. Generally, orally administered medications are most desirable as owners can administer them at home, but oral drugs can be difficult to administer reliably in an effective time frame depending on the animal's feeding schedule and willingness to accept food and/or

medication. Injectable medications are frequently administered subcutaneously, intramuscularly, intravenously, or intracoelomically, and are usually uncomplicated in reptiles but do require increased veterinary attention to administer. Topical medications such as liquids, creams, or baths are also common therapeutics employed.

Most aspects of veterinary care, from diagnosis to treatment, can be facilitated with operant conditioning. Additionally, trainers, who are well-versed in observing animal behavior, are able to spot tiny changes in an animal's behavior,[12] which can be critical to detecting subtle signs that may indicate a veterinary problem. This article will review how training techniques can minimize stress and maximize veterinary care in captive reptiles.

REPTILE COMMUNICATION AND COGNITION

Reptile Communication Channels

Communication is defined as "the cooperative transfer of information from a signaler to a receiver."[13] Humans have very familiar ways of transferring information, intentions, and desires with other mammals. Verbal cues and hand gestures are used with great success when training other mammals that have acute vision and hearing. However, reptiles have modes of communication that are less familiar and require a different training approach. When training reptiles it is important to understand the specific species' communication channels. Generally speaking, communication in reptiles occurs visually, acoustically, tactilely, and chemically, with animals often relying on multiple methods to receive input simultaneously.[13]

Visual communication in reptiles can range from the movement of a specific body part to dramatic color displays. An obvious example of visual communication is a head bobbing display for courtship or territoriality in many species of lizard.[13] Body coloration and color change can be sexually dichromatic and are forms of visual communication.[14] In laboratory studies conducted on highly visual lizard species, females painted with male coloration elicited aggressive behavior from other males when placed in terraria, and similar responses were documented when males were painted with female coloration.[14] Specific snake species, such as king cobras (*Ophiophagus hannah*), are highly visual hunters that respond to prey movement. It has been suggested that tortoises seek out brightly colored vegetation in foraging for food[15] and crocodilians are known to be very visual predators.[16] Many species utilize courtship gestures, submissive postures, tail displays, and various signaling mechanisms in communication.[14]

Auditory communication is evident with various reptile species across many taxa, including vocal calls, bellowing, body parts being rubbed to produce a sound, and slapping the body against a specific surface, such as head slaps in water with crocodilians.[13] New research also indicates that snakes may in fact hear air-borne sounds.[17] There is even evidence that a nonvocal reptile, the Galápagos marine iguana (*Amblyrhynchus cristatus*) can hear and utilize the alarm call of the Galápagos mockingbird (*Nesomimus parvulus*) to respond with its own anti-hunter behaviors to their shared predator, the Galápagos hawk (Buteo galapagoensis).[18]

In tactile communication, an animal uses its body to rub, press, or hit another animal. In tortoises this manifests as neck biting, hindlimb stroking, chin rubbing, spur stroking, shell ramming, and biting[14]; caudocephalic and cephalocaudal waves are seen in snake courtship and are best described as contractions of movement against the female's body prior to copulation.[14] Snakes interpret ground-borne sounds through vibration transferred through the body to the skull,[19] in addition to air-borne sounds.[17] This concept of sensation through touch can be used in a training

program. For example, tortoises will respond to neck rubs and tactile reinforcers and snakes can respond to cues that cause slight vibrations when training.

A primary mode of communication for many species of reptile is chemical signaling. Many species rely heavily on skin and cloacal secretions during mating. An experiment involving garter snakes (*Thamnophis sirtalis* and *T butleri*), where estrous females were covered with petroleum jelly to conceal signaling by skin secretions, showed that males that were once receptive were no longer interested in mating with the females.[20] Snakes and lizards have highly developed senses of smell that can be utilized in a training program; for example, an effective training method is to use a prey scent trail to train a snake to move when needed, taking advantage of a natural predatory behavior in the animal—seeking prey by scent—to accomplish a desired behavior with reduced stress (Janis Gerrits, Washington, DC, personal communication, January 2012).

Reptiles are a diverse group of animals that require varied training approaches to appeal to specific physiologic and behavioral tendencies or inclinations for each taxon. When approaching training opportunities with such a vast number of different species, the natural history, and communication channels of each should be studied and incorporated into the training plan.

Reptile Cognition

It is a common misconception that ectotherms lack cognitive abilities. Research has demonstrated that reptiles display behavioral complexity and have the ability to learn.[21–25] For example, behavioral complexity and play in a Komodo dragon (*Varanus komodoensis*) at the Smithsonian's National Zoo were documented by introducing a series of objects to the lizard. This study suggests significant cognitive abilities of this large, long-lived reptile, which has been trained at many zoological institutions to allow behavioral restraint for veterinary care. A related species, the black throated monitor (*Varanus albigularis*), has also shown cognitive and problem solving abilities, learning how to open a hinged door to gain access to food items.[26] Operant conditioning has been increasingly used with reptiles in zoological settings over the past 10 years[22,23,25,27–29] to facilitate veterinary care and more complex approaches reflecting reptile intelligence are being incorporated into training programs. For example, 4 adult Aldabra tortoises (*Geochelone gigantea*) learned to associate a clicker with food, to target, and then to hold still with their necks extended to the target to allow venipuncture of the jugular vein.[25] In another example, a Nile crocodile (*Crocodylus niloticus*) was taught to associate a whistle with food, then target and station on cue, which eventually allowed staff to obtain a weight and blood draw without sedation or restraint.[22] Studies in indigo snakes (*Drymarchon corais*) have shown that their rate of response to operant conditioning is similar to comparable studies of rats that had been trained to press levers or disc-pecking pigeons.[30]

Previously mentioned examples of reptilian cognitive abilities and training successes have focused on large animals that many veterinarians may never see in their offices. However, there are examples of smaller reptile species displaying cognition. Researchers at Duke University documented problem solving in the emerald anole (*Anolis evermanni*), where the animal demonstrated the ability to problem solve by removing a disc to gain access to a covered food item.[31] The test subjects also learned to discriminate between the target and a distracter disc placed in close proximity to the target, displaying cognitive abilities and behavioral flexibility comparable to many endothermic species. With documented case studies, new research emerging,

and continued success in various reptile training programs in zoological settings, it is clear that reptiles have significant cognitive abilities.

REPTILE TRAINING

Benefits of Operant Conditioning

Behavioral training has many purposes and benefits for animals including physical exercise, mental stimulation, reducing stress, research, work and service functions, increased safety, cooperative behavior, and more. But one of the most important reasons for training animals is to better provide for the animals' physical and mental welfare.[32] And contrary to the beliefs of some, there are no boundaries as to which species can be trained.[33]

Veterinary care is an important part of a captive animal's life, and it is in the best interests of all involved to make the process as positive as possible. Stress can have adverse impacts on reptiles and as such should be minimized when possible. Studies on farm and laboratory animals show that handling for some veterinary procedures can be stressful, but if the animals learn to associate desired consequences with these interactions, the degree of fear responses they exhibit can be reduced.[34] This is certainly applicable to reptilian taxa, and should be considered when owning, housing, and treating any captive specimen.

Training has proved to be beneficial in mammals, producing more accurate diagnostic analysis for biochemical data. In rhesus monkeys (*Macaca mulatta*), cortisol levels were significantly higher when animals were trained versus restrained for blood collection.[35] Other research has shown reductions in stress hormones[36,37] and stereotypic behavior[38] as beneficial effects of training. Similar results have been described in bongo (*Tragelaphus euryceros*) with significantly reduced cortisol levels for crate-trained animals when restrained in the crate for 20 minutes,[39,40] close to baseline cortisol levels for resting cattle.[41,42] The bongo trained for restraint had lower creatine phosphokinase and glucose levels than animals immobilized by dart or pole syringe.[40] Livestock cared for by workers who build relationships (eg, patting, stroking, moving slowly) versus ones who use aversive interactions (eg, quick movements, shouting, hitting) showed reduced fear of humans.[43,44] Lab-housed stump-tailed macaques (*Macaca actdoides*) considered friendly by caretakers received more attention and interactions, were less disturbed by procedures, and were more likely to approach and accept food from caretakers.[45] And in a zoo study, reproduction in small exotic cats was more successful when keepers spent time interacting with the animals.[46] These studies are evidence that teaching animals to cooperate in their own health care can make life less stressful for both the animal and the trainer.[32]

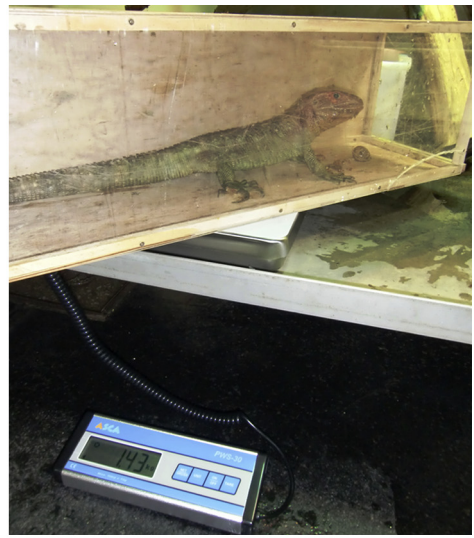
Safety is a primary concern when working in close proximity to any animal. Both animals and people are at risk due to fear-based behavior. Animals showing fear responses can be dangerous animals.[47] They are more likely to injure themselves or their handlers than are animals that are not showing behaviors indicative of fear.[41,48,49] All vertebrates can learn to associate a fear response with certain stimuli.[50,51] Some animals learn to pair a fear response with the presence of the veterinarian.[47] Operant conditioning can also be used to reduce fear responses and pair positive reinforcers with the veterinarian and medical procedures. Training animals to cooperate with handling procedures helps reduce stress and accidents,[47] thus improving safety for humans and animals alike (**Box 1**).

Even with potentially dangerous animals such as venomous snakes, there are a variety of tools made specifically for working more safely with them, including hooks,

Box 1
Case Study 1: Caiman Lizard (Dracaena guianensis), Schönbrunn Zoo, Vienna, Austria

The caiman lizard is a large, semi-aquatic lizard from the Amazon River basin can reach at least 412 mm SVL (snout-vent length). These carnivorous reptiles spend time both in trees and in water, and hunt snails as their primary source of prey (Mesquita et al, 2006).

The Schönbrunn Zoo in Vienna, Austria received 2.2 caiman lizards from a breeding farm in Peru in August 2008, when the animals were 8–12 months of age. Once the animals were stable and eating consistently in an off exhibit area, they were moved to a large, 40 square meter enclosure; designed with many plants, rock walls, a river with a pond, and a variety of climbing structures. The lizards were fed their favorite food – apple snails – in two or three different locations throughout the enclosure.



Left to right: Caiman lizard being desensitized to handling gloves, caiman lizard targeted into box and on scale, caiman lizard targeting onto x-ray cassette for radiographs. (*Courtesy of* Archiv Tiergarten Schönbrunn; *Data from* Mesquita DO, Colli GR, Costa GC, et al. At The Water's Edge: Ecology of Semiaquatic Teiids in Brazilian Amazon. J Herpetol 2006;40(2):221–9.)

After a short time in their new exhibit, a variety of management problems arose. One female lizard became quite dominant and aggressive towards the others, and was able to eat most of the snails; and was also the likely culprit in a tail injury received by the other female. One of the male lizards hid, probably in the rock wall, and wasn't able to be located for several weeks.

To help mitigate these problems, a behavioral training program was implemented, with an initial goal of being able to individually feed and check each animal regularly. A second goal was to desensitize the lizards to handling, because after each time the animals were caught up for any reason, they exhibited fear and stress behaviors for a long period afterwards.

Training began in a terrarium behind the scenes. Some individuals allowed keepers to approach closely enough to offer snails with tweezers, and some required more intensive training to get to this point. After spending some time pairing a clicker (as a bridging stimulus) with a snail, a target pole was introduced, and the lizards soon learned to touch and follow the target. Targeting was used to guide the lizards over a variety of different materials for desensitization, such as cloth, metal, wood, and leather; and they learned to follow the target through objects such as pipes and boxes, including into a transport crate. The desensitization training allowed the staff to begin touching and handling the lizards with heavy leather gloves without stressing the animals; and the targeting behavior also allowed keepers to train the lizards to go into a crate voluntarily. The crating behavior was useful for a wide variety of other management and veterinary behaviors, as the crate could easily be placed on a scale to obtain weights, and over an x-ray film cassette for radiographs. The lizards were also able to be targeted directly on to the film cassette for radiographs as well, which added flexibility in utilizing this diagnostic tool.

The training program has been very successful in helping to better and more safely manage this amazing species. The staff discovered that in addition to easier and less stressful handling, the lizards are now more relaxed in the presence of the keepers and they show less aggression to each other within the group.

tongs, shields, snake cans, and tubes.[52] Utilizing the proper tools in combination with operant conditioning techniques, it is possible to train many reptilian species regardless of their size or venomous nature (**Box 2**).

Utilizing Training in Veterinary Care

There are numerous behaviors that can be used to facilitate many aspects of veterinary care, from diagnosing the problem to administering treatment. Reptiles respond to operant conditioning, and training should be used to minimize stress and maximize the ability to medically evaluate and treat these animals. This section will focus on some of the more useful behaviors and their application to veterinary exams, and will review specific examples (Appendix 1) of how training and desensitization enable veterinary procedures with reduced stress.

Desensitization

"Desensitization is the process of getting an animal used to a new stimulus through gradual exposure to it. The stimulus may be people, other animals, noises, lighting, or anything the animal may perceive as new or frightening."[32] Desensitization can be trained with both active and passive methods. Passive desensitization is called habituation, where an animal gets used to new things on its own over time, without active involvement from a trainer and without pairing the association with reinforcement.[32] With this technique the animal needs to be able to choose to go near or interact with the new stimulus; it should not be forced into close proximity or it might result in increased fear responses.[53]

Box 2
Case Study 2: Nile crocodile (*Crocodylus niloticus*), Wildlife Conservation Society, Bronx Zoo, Bronx NY

The Nile crocodile is a large predator native to Africa, which can grow to lengths of 6 meters (Trutnau and Sommerland 2006). Likely because of their impressive size, Nile crocodiles are one of the most commonly kept crocodilian species in captivity. However, their size and physiology creates many challenges to maintaining them in captivity.

In response to these challenges, the Bronx Zoo utilized operant conditioning to facilitate examining and treating large crocodilians in captivity. A training program for an adult male Nile crocodile was initiated in May 2008 soon after his arrival. First a whistle bridge was conditioned; then a target behavior was trained. Initially mastering targeting in the water, the animal's potential was quickly seen and the keepers began opportunistically working him on land.

To take this training further, a protocol for blood draw training was drafted. But before this training could commence there were some safety concerns to be addressed. Entering the exhibit with an eight-foot Nile crocodile is dangerous, and facility modifications were completed to reduce the risks and safeguard the keeper and veterinary staff. The animal was slowly habituated to human presence in the exhibit and then desensitized to touch on his tail. With a combination of facility modifications for safety, desensitization to a variety of people and stimuli, and step by step operant conditioning techniques, the crocodile was able to be stationed on a scale and blood was successfully collected in March 2010.

The use of this training could have tremendous ramifications. By desensitizing this animal to touch as well as habituating him to human presence, veterinarians can safely approach this animal for physical exams, injury assessments and treatments. The collection of regular blood samples could allow veterinary staff the ability to further study crocodilian disease and treatment as well as document normal blood values for that animal and the species. In addition this behavior could possible allow for injectable treatments on this animal if necessary.

Data from Trutnau L, Sommerland R. Crocodilians: Their Natural History and Captive Husbandry. 1st edition. Frankfurt (Germany): Brahm AS; 2006.

Active desensitization, or counter conditioning, is a process where the new stimulus is paired with or followed by reinforcement to create a positive association with that stimulus.[32] Counter conditioning gives the trainer more control over the process and progress can frequently move at a more rapid pace than habituation. Both methods of desensitization can be beneficial in the training of cooperative behaviors for veterinary visits and examinations. The involvement of veterinarians in desensitization for veterinary visits and medical behaviors is critical. They are needed stimuli that will be present for procedures and should therefore be part of the training process. Other training includes desensitizing the animal to the equipment that will be used, the physical contact that is required for the exam, the duration of the procedure, and the number of people that need to be present.[32]

Taking the time to get animals used to and comfortable with the situations and equipment they might encounter in a veterinary visit can go a long way in making a more receptive and cooperative participant. The Denver Zoo routinely handles several species of non-venomous snakes to desensitize them to veterinary exams (Patricia Anderson, Denver, CO, personal communication, January 2012). At the Schönbrunn Zoo in Austria, keepers desensitized their Caiman lizards (*Dracaena sp*) to leather gloves and veterinary equipment to prepare them for veterinary visits (Dr Eveline Dungl, Vienna, Austria, personal communication, January 2012) (**Box 3**). At the North Carolina Zoo, keepers desensitized an American alligator to a sit under a nebulizer for pneumonia treatments (Chris Shupp, Asheboro, NC, personal communication, February

Box 3
Case study 3: False water cobras (*Hydrodynastes gigas),* Smithsonian's National Zoo, Washington, DC

False water cobras are rear fanged, venomous colubrids that occur naturally in South America (Greene, 1997). They are large semi-aquatic snakes, feeding mostly on frogs and fishes (Bels, 1987; Strüssmann & Sazima, 1993). Their biology makes them great exhibit animals, utilizing aquatic, terrestrial, and arboreal features in the exhibit at the Smithsonian's National Zoo.

Three juvenile false water cobras are exhibited together in the Reptile Discovery Center. When multiple snakes are housed together, feeding the animals in a manner that avoids conflict, aggression, and possible ophiophagia (eating of the other snakes) is of top concern and usually results in the animals being separated during feeding. Typically, venomous snakes are hooked off-exhibit into a secure holding container (referred to as canning) for routine exhibit maintenance and feedings. False water cobras are known to be very active, vigorous feeders which can be a challenge, but in this circumstance, proved to be a wonderful training opportunity. To date, each individual animal has been successfully trained to follow a scented target pole into an off-exhibit holding can for each feeding session. By scenting a target stick, animals are enticed to follow the target stick and willingly enter the can. The animal is rewarded for this behavior with mice left in the bottom of the can.

This has proven to be an effective tactic used while performing routine husbandry practices, and many future uses as well. It is now a very easy task to weigh and manipulate the animals into any number of containers for safe handling, allowing for veterinary assessment and possible treatments. Additionally, this training likely reduces the stress for animals and keepers by minimizing hooking efforts, as well as decreasing the time it takes to separate and move animals.

Data from Refs.[65–67]

2012); and at the Fort Worth Zoo, a Komodo dragon has been desensitized by the keeper staff and is trained to allow a mask to be placed on its head for anesthesia during veterinary exams (Diane Barber, Fort Worth, TX, personal communication, February 2012).

Animals that are regularly handled for routine procedures are likely to experience less stress when captured for an uncommon procedure.[54] As one trainer put it, "We teach the animals to help us take care of them … we teach the animals that going to the vet is a game and we play that game every single day, whether a vet is there or not. And those 'games' include numerous veterinary or cooperative behaviors. To the animal, it's just part of the training session."[55]

Tactile Desensitization

An important behavior to teach animals for a veterinary examination is to accept tactile stimulation.[56] While not every species or individual is amenable to this technique, animals that have been taught to accept being touched will be easier to manage. And, although some animals may seem to solicit petting or tactile interactions, this does not automatically mean they will do so for medical procedures. Desensitization is a critical component to establishing reliable tactile interactions and is helpful for husbandry procedures.[32] Tactile desensitization training should begin with parts of the body where the animal is most receptive to touch, and the animal should never be surprised by the touch.[57] Animals should be made aware that a touch is going to occur, either through a verbal signal or other sensory cue. This strategy can help reduce potential aggressive behavior from a surprised animal and help prevent damaging the trust between the trainer and animal.[56]

At the Smithsonian's National Zoo, daily habituation and tactile desensitization has become a key component in the medical care of an adult male Komodo dragon. As part of this animal's management, cleaning and exhibit maintenance are done in the morning, and feeding in the afternoon. Every morning, when the animal's body temperature is lower and it is less active, the keeper completes the needed exhibit work and then engages the animal with tactile interaction. Over time, the lizard has become habituated to this routine, and the veterinary team is able to enter the animal's enclosure and obtain radiographs without heavy restraint or sedation (Janis Gerrits, Washington, DC, personal communication, January 2012).

Targeting/Stationing

Basic behaviors such as targeting and stationing are excellent ways to position and manipulate an animal in order to better assess health concerns. A target is an object that an animal is taught to touch, follow, or go to. It can be a ball on the end of a stick, a hand, a straw, spoon, or any object that the animal can perceive and is safe to use.

Once an animal understands the target behavior concept, targeting can be used as a tool in training many other behaviors. It can be part of an active desensitization program, where an animal follows a target to, and even on or through, novel items (Dr Eveline Dungl, Vienna, Austria, personal communication, January 2012). It can be used to teach an animal to go onto a scale, into a crate, and countless other behaviors. For example, the Colchester Zoo used the targeting behavior to move their crocodiles and Komodo dragons for examination, to obtain weights, blood draws, ultra sounds, nail trims, and to apply topical medication (Jez Smith, Essex, United Kingdom, personal communication, January 2012). These behaviors are sometimes initiated with baiting or luring—where the animal is shown food or food is put on/in the desired item (ie, crate or scale) to entice the animal to approach. Baiting, while a useful training tool, can be problematic if the animal needs to be fasted for medical reasons but requires food in order to perform a task.[56] Targeting is a much more effective tool in these instances.

Stationing is an offshoot of the targeting behavior; it refers to training an animal to go to a specific item or location, and tells the animal where it is expected to be for a behavior or during a training session.[32] When training a reptile for veterinary care, the station can be a familiar item that carries reinforcement value in an unfamiliar environment. For example, if an animal is trained to station on a piece of Astroturf, this can easily be brought to the veterinarian's office and put on a scale or exam table for stationing during the exam.

Both stationing and targeting are foundation behaviors that are at the core of a good training program. If they are trained to fluency, they offer the animal the opportunity to present a behavior that has a strong history of positive reinforcement in a veterinary setting. This can potentially lead to a more relaxed and cooperative patient in an unfamiliar environment.

Box/Squeeze/Tube

Training an animal to enter a mobile shift or squeeze box can reduce stress for transportation and can be useful for basic husbandry. This can be a permanent or temporary attachment to the animal's enclosure and should be dark, warm, or in some way attractive to the reptile. Animals can be fed in the shift box, so that the reptile has a positive association with the shift. At the Buffalo Zoo, black tree monitors (*Varanus beccarii*) have been trained to station in a plastic container for weighing (Penny Felski and Illa Caira, Buffalo, NY, personal communication, February 2012).

The shift box can be a clear, acrylic squeeze cage so that the patient can be visually inspected by the veterinarian, and so that the animal can be restrained into a smaller space to receive injections, facilitate anesthesia, or accomplish blood draws. Several institutions have animals trained to enter clear containers for veterinary exams, including poison dart frogs (*Dendrobates* sp) at Disney's Animal Kingdom (Mindy Sommer, Lake Buena Vista, FL, personal communication, January 2012), green mamba (*Dendroaspis angusticeps*) at the Brookfield Zoo (Tim Sullivan, Brookfield, IL, personal communication, January 2012), and Komodo dragons at the Toronto Zoo (Nicole Presley, Toronto, Canada, personal communication, February 2012), and Singapore Zoo (Sarah Chin, Singapore, personal communication, February 2012).

Another tool is a snake immobilization tube that, when combined with operant conditioning, can be a highly effective method for safely handling and examining venomous species. Operant conditioning can be used to train the snake to enter the tube voluntarily rather than with force. One method utilized at the Riverbanks Zoo was to use the targeting behavior to train a king cobra to enter a tube. This, however, proved more difficult than anticipated so keepers had to initially bait, or used food to entice the animal into the tube.[28] Baiting allowed the animal handlers to desensitize and eventually target train the snake into the tube.[28]

CHALLENGES IN TRAINING REPTILES

Although training is a useful tool for facilitating veterinary care, there are many challenges that must be addressed when training reptile species. It is important to remember the animal's health and welfare is top priority, and training should not commence if it compromises the animal's health.

Overfeeding

The food requirements of reptiles vary depending on the specimens' size, age, temperature, activity,[58] and reproductive status.[59] As ectotherms, reptiles are characterized by low metabolic rates and high conversion efficiencies.[60] Overfeeding is a commonly seen problem with amateur herpetologists.[61,62] Obesity can increase the likelihood of liver disease, cardiac disease, arthritis, and renal disease.[58] When designing a training program it is imperative to keep the animal's diet consistent and appropriate for the species and individual.

Frequency of Feeding

The time and frequency of feeding reptiles is of significant importance when training. Some species will readily eat any time, while others are strictly nocturnal or diurnal feeders.[63] Additionally, many species will fast for weeks or months in the wild as an adaptation to the natural environment or reproductive status and this can persist in captivity.[63] The frequency in which animals are trained and fed will directly affect the success of a training program. Most mammals eat several times a day, making the potential training regimen much more intensive than that of a reptile that can consume as little as 1 meal a month in captivity. In order to maximize training sessions with these animals, it is imperative to use every feeding session as an opportunity to train the animal. Caregivers can increase the frequency of training and still maintain the animal's caloric intake by offering smaller food items that, cumulatively, are the equivalent to one large meal. Feeding several small items or portions instead of one large meal can increase training approximations during each individual session.[29] Each species' natural feeding behavior should be taken into consideration when a dietary change is made for training purposes. For example, grazers such as tortoises can

easily have their diet split up and offered to them throughout the day, but this strategy may not be as feasible with all reptilians.

Food Delivery

Understanding how reptiles perceive the world is important when feeding a captive specimen. Reptiles use several senses simultaneously when feeding; in particular olfactory, visual, and thermal cues. When approaching an enclosure with food, the olfactory cue has likely been delivered and the next cue is the visual presentation of food. Reptiles have varying degrees of vision, snakes for the most part have relinquished an emphasis on visual cues[19] where lizards are often utilizing vision for prey and mate selection.[64]

A challenging aspect of training reptiles is delivering the food reinforcer safely and in a timely manner, especially when working with venomous species and/or animals known for aggressive behavior. This can then be exacerbated when multiple animals are in an enclosure together. Hand delivery of food poses risks. Hand delivery requires the trainer's hand to get within close proximity of the reptiles' mouth. If tossing the food, there is a chance the animal may miss the food item and/or see the movement of the trainer's hand and perceive that quick motion as the food. Both of these examples can cause injury or adversely affect training outcomes. Many tools are available to effectively deliver food to animals when training including tongs, feeding sticks and forceps.

If an animal is hesitant to approach the caregiver, proximity training can be an effective method of slowly desensitizing the animal to a person's presence during feeding. This training, combined with the different lengths of tongs available, can ease the animal into the new feeding regime.

When utilizing feeding tools the delivery is often slower, providing the animal with a number of cues or signals that food is coming, making reinforcing the desired behavior challenging. The olfactory cue, in combination with a slow delivery of food, can elicit an aggressive feeding response that may inadvertently be reinforced. This type of feeding response can be minimized by training the animal to sit at a station where feeding will occur.

Tools, especially tongs, are often used for cleaning, feeding and manipulating the animal or cage furniture. When a tool is used repeatedly to feed an animal, the animal may form an association between it and the food. When used for other purposes, the tongs will likely elicit a feeding response even when not being used for feeding. Additionally an animal can sustain an injury during tong feeding if it is overly motivated to feed. Animals that are new to tong feeding tend to bite the tongs and abrade in and around the mouth. This can be avoided by using padded tongs, and reinforcing and shaping a calm feeding behavior.

A feeding stick is another option for delivering food reinforcers. A dowel rod or other similar item can easily be fashioned into a feeding stick by whittling one end into a dull point. This point can be used to skewer food onto the end of the rod, without posing a danger to the animal. Another tool option is forceps, which are used much like tongs and come in a variety of lengths. These are appropriate for aquatic species and species that eat small prey. They will allow delivery of the food while maintaining a safe and comfortable distance, without overpowering the food with a large delivery tool. Forceps might also minimize the feed response to a multipurpose tool like tongs.

Environmental Conditions

The environmental conditions that are ideal for keeping reptiles can prove to be yet another challenge for training. Reptile enclosures are usually small, are kept at higher

temperatures, and are uniquely designed to the species being exhibited. For example, an enclosure might require a significant amount of perching for a particular species or a large pool of water for a semi-aquatic species. When attempting to train a reptile, especially a small lizard or snake, the door must often remain open during the session. When working with quick moving species, minimizing or eliminating animal escapes needs to be a priority. To avoid escapes from enclosures, it is best to move the animal to a more appropriate training space, or when this is not possible, training the animal to station away from the door can increase safety and reduce the risk of an escape.

Reptiles may be housed individually, in pairs, or in social groups. Housing animals together may cause dominance hierarchies amongst the animals, and more dominant animals to over-eat while submissive animals receive less food. Dominant animals will generally be more easily trained. Forming a relationship with the more submissive animal can be difficult, especially with the dominant animal(s) present. Removing a reptile from the enclosure can help focus on training goals with the other animal. At the Smithsonian's National Zoo a keeper trained a very active and food motivated Mertens' water monitor (*Varanus mertensi*) to follow a target into a holding container in order to isolate and train the animal's exhibit mate (Janis Gerrits, Washington, DC, personal communication, January 2012).

Paradigm Shift

While the use of operant conditioning training to facilitate management and veterinary care has gained more widespread acceptance in recent years, its application with reptiles and amphibians has lagged behind that of their mammal and avian counterparts. This could be due to the ease with which many reptiles can be involuntarily picked up or restrained for examinations, or it could be related to the lack of reptile and amphibian training models for caregivers to learn from. For those who work with or own mammals or birds, they can look to an abundance of examples of training; from dog training for obedience and agility to an array of animal shows at zoos and aquariums with a wide variety of taxa. Even when reptiles are involved in these types of shows and demonstrations, they are generally carried or held, and rarely are shown being trained to exhibit active or natural behaviors during these programs. A paradigm shift is needed, with keepers, owners, and veterinarians learning about and embracing the benefits of operant conditioning as a critical component in the care of reptiles and amphibians.

Even once this paradigm shift occurs, a challenge still remains. Operant conditioning is a skill set that must be learned; reptile owners and veterinarians need to make an effort to learn this useful technology to benefit their animals. While there are many wonderful training resources available, there are none dedicated to the specific challenges of working with reptiles and amphibians. Fortunately, training is training, and the art and science of animal training is transferable to any species, any animal.[53]

SUMMARY

Reptiles are capable of responding to operant conditioning and should have training programs incorporated into their captive husbandry. Of the many benefits training affords, the most important is its use in diagnosing and treating an ill animal. Veterinary clinicians should inform their clientele about the benefits operant conditioning can provide for the reptiles in their care.

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APPENDIX 1: EXAMPLES OF TRAINED BEHAVIORS FOR FACILITATING VETERINARY PROCEDURES IN REPTILE SPECIES FROM ZOOLOGICAL INSTITUTIONS WORLDWIDE

Institution	Species	Behaviors
Blank Park Zoo, IA	Aldabra tortoise, Geochelone gigantea	Target (weights, moves), Mouth open (oral exam) Desensitization (blood draws, diagnostic imaging, eye drops, eye pressure test, weights, foot exam)
Buffalo Zoo, NY	Black tree monitor, *Varanus beccarii*	Shift/Plastic container (weights, visual exam, diagnostic imaging)
Chicago Zoological Society-Brookfield Zoo, IL	American alligator, *Alligator mississippiensis* Green mamba, *Dendroaspis angusticeps*	Eye drops Shift container (anesthesia, exams)
Colchester Zoo, United Kingdom	Komodo dragon, *Varanus komodoensis* Crocodiles (various sp)	Station/Desensitization (diagnostic imaging, blood draws, nail trims, topical medications, weights) Target (exam)
Disney's Animal Kingdom, FL	Dart frogs, *Dendrobates sp*	Station (exam, weights)
Denver Zoo, CO	American alligator, *Alligator mississippiensis* Various species	Station (reduce aggression) Station/Desensitization (exam)
Fort Worth Zoo, TX	Komodo dragon, *Varanus komodoensis* Water/yellow tree monitor, *Varanus sp* Indian gharial, *Gavialis gangeticus*	Desensitization (anesthesia) Target/Desensitization (exam), Crate (exam, moves) Target (exam), Station (exam, oral medications)
Mandalay Bay, NV	Komodo dragon, *Varanus komodoensis* Crocodiles/sea turtles (various sp)	Target (exam, moves), Desensitization (nail trims), Crate (diagnostic imaging, exam, blood draws) Target (exam, moves), Crate (diagnostic imaging, exam, blood draws)
Melbourne Zoo, Australia	Aldabra tortoise, Geochelone gigantea	Target (weights), Desensitization (exam, blood draws, topical medications, diagnostic imaging, mouth inspection)

Riverbanks Zoo, SC	King cobra, *O*phiophagus hannah	Shift/Tube (exam)
Schönbrunn Zoo, Austria	Morlett's crocodile, *Crocodylus moreletii*	Target (moves)
	Giant tortoise (various sp)	Target (moves, weights), Desensitization (exam)
	Caiman lizard, *Dracaena guianensis*	Crate (weight, diagnostic imaging), Desensitization (handling with gloves)
Sedgwick County Zoo, KS	Aldabra tortoise, Geochelone gigantea	Target (weights), Station/ Desensitization (blood draws)
Singapore Zoo, Singapore	Komodo dragon, *Varanus* komodoensis	Target (exam, moves), Desensitization (exam, diagnostic imaging)
Smithsonian's National Zoo, DC	Poison dart frogs, *Dendrobates sp*	Target (move to increase UVB intake)
	Indian gharial, *Gavialis gangeticus*	Crate (moves)
	Aldabra tortoise, Geochelone gigantea	Target (weights), Station (cooperative feeding)
	Komodo dragon, *Varanus* komodoensis	Desensitization (exam, diagnostic imaging)
	False water cobra, *Hydrodynastes gigas*	Target (shift off exhibit)
Theater of the Sea, FL	American alligator, *Alligator mississippiensis*	Target (moves, exam), Lift feet (exam, topical medications), Station (weights)
Toronto Zoo, Canada	Komodo dragon, *Varanus komodoensiss*	Shift/Crate (exam, nail trims, diagnostic imaging)
	Dwarf crocodile, *Osteolaemus tetraspis*	Shift (exam)
	Nile monitor, Varanus niloticus	Shift (exam)
	Chinese softshell turtle, Pelodiscus sinensis	Target (exam)
	American alligator, *Alligator mississippiensis*	Target (move, exam)
	Nile softshell turtle, Trionyx triunguis	Target (exam, weights), Desensitization (shell scrubs, topical medications, exam, crate)
UC Davis, CA	Snakes, tortoises, lizards (various sp)	Desensitization (restraint, exam, injections, diagnostic imaging, anesthesia)
Wildlife Conservation Society-Bronx Zoo, NY	Nile crocodile, *Crocodylus niloticus*	Target (exam), Station (exam, weights), Desensitization (exam, blood draws, zip-tie on snout)
Zoo Atlanta, GA	Aldabra tortoise, *Geochelone gigantea*	Target (weight, exam)
	Komodo dragon, *Varanus komodoensis*	Station (on wire mesh for nail trims)