Experimental Application of Conditioned Taste Aversion (CTA) to Large Carnivores

by
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In this article, I will introduce the most important concepts underlying the application of Conditioned Taste Aversion (CTA) as a potential wildlife management tool. This method has been much maligned over the years. After the first experiments by psychologists reported promising results with several species, many biologists who had no training in psychology attempted to replicate the experiments. Their efforts were largely unsuccessful and they concluded in published reports that the method did not work. This conclusion is contrary to the scientific method, in which success is the standard and it is incumbent upon those who obtain negative results to determine why they have failed. As a consequence of bitter political battles over CTA, as well as the stringency and expense of U.S. Environmental Protection Agency registration of chemicals for specific purposes, CTA fell completely out of favor in the U.S. as a method to mitigate carnivore predation on livestock. It is impossible for any of us who have been involved with this subject for decades to write without accusations of "hidden agendas" and biases. Nonetheless, years later, detractors of this technique continue to publish inaccurate reports and the results of flawed studies.

Conditioned taste aversion (CTA) is a psychological phenomenon that has been studied for over fifty years, primarily in the laboratory. Naturalists who recognized its role in Batesian mimicry originally described it, however. Harmless butterflies mimicked the eye-catching colors and patterns of toxic butterflies, in order to avoid predation by birds. Early in life, most adult birds had become ill after eating the toxic butterflies and had acquired CTAs to them. Once a taste aversion developed, even the visual characteristics of the prey elicited avoidance by the predator.

Most people have had similar experiences with foods. Once a food is eaten, either of two outcomes may result. First, the food may be nutritious. In that case, digestion leads to absorption of needed nutrients and when the food is encountered again, its value will have been enhanced by that positive experience. Alternatively, the food may be tainted with bacteria that lead to severe gastro-intestinal illness. In that case, vomiting often eliminates the food and eventually, the person recovers. When that same specific food taste, or even odor, is encountered again, however, its value has been seriously discounted by the illness experience. Typically, people eat less of the food and will report that it tastes and smells disgusting or sickening. Sometimes, aversions are learned in a single trial and the food may be refused entirely for years thereafter. Interestingly, the illness does not even have to be *caused* by the food. If a person ate a food shortly before becoming violently seasick, for example, his or her preference for the food would decrease, even though the person knew, logically, that their illness had nothing to do with the food eaten. To them, the food just tastes *bad*. Similarly, taste aversions can be acquired when animals are sedated or anesthetized during illness.

CTA is a special form of learning, as has been demonstrated in literally thousands of experiments published over the years in leading psychological journals and books. CTA is one of two systems of natural defense used by organisms, in which *cues* or *signals* and *consequences* are associated via learning.

The defense system that most people are familiar with is the *external* defense system. This system protects us, and virtually all other organisms, from predation, accident and injury. Characteristics of learning in the external defense system are that it 1) requires cue and consequence to be only seconds apart; 2) often involves some cognitive processing; 3) involves consequences that produce pain and fear, and 4) requires repeated trials to establish a learned response. An example is the type of learning that a subordinate animal develops during rough and tumble play, when repeated associations of particular dominance behaviors with painful bites lead to appropriate submission. By similar experiences, young children learn the meaning of words like "Hot."

The less familiar defense system is the *internal* defense system. This protects humans, and virtually all other organisms, from accidental poisoning by toxins that are present in the natural environment. Characteristics of learning in the internal defense system are that it 1) tolerates cue and consequence separations of hours; 2) is an emotional reaction and develops in the absence of cognition; 3) involves consequences that produce disgust and loathing, and 4) requires one or only a few trials to establish. Examples have been given above.

CTA has been demonstrated in virtually every species tested, from praying mantis to people. The association between taste and illness is fundamental to aversion learning. Odors or visual cues also associated with the taste can be powerfully affected during aversion learning, but they are not the primary basis of the learning. It is important to recognize that intervening external events do not interfere with development of an aversion. Thus, a confined animal might be badly frightened during the process of a procedure involved in application of CTA. Common sense might suggest that the "aversion" would be developed to the external events that produced the fear reaction: people, loud noises, restraint, etc. This, however, is not the outcome. The people it associates with restraint may indeed frighten the animal, but its subsequent taste aversion will have nothing to do with the presence of people. The animal will refuse the food even in the absence of people.

Once established, taste aversions are often extremely long-lasting. This can be explained by the principles of behavioral ecology – the economics of an animal's survival. Predators will often launch an attack on a prey animal whose flesh they have acquired an aversion for, only to break off the attack at the smell or taste of the hide. Thereafter, they typically avoid the prey from a distance and do not even attack. Why? Predation is an energetically costly undertaking. Prey must be found, and ambushed or stalked, charged and killed. Predators often need to defend their kills from other carnivores, as well. It is not in the best interests of predators to expend such energy, only to refuse to eat the killed prey because it no longer tastes good to them.

The key point to understand is that these prey items do not taste any different than usual to an animal that does not have a taste aversion for that specific prey. The application of CTA is not a process of applying a particular bad-tasting or bad-smelling toxic chemical to all of the livestock that is in need of protection. That is simply the application of another form of avoidance or external learning. Many permutations of this have been tried and have failed over the years. In that scenario, the predator learns to discriminate, by visual or olfactory cues, between prey that are treated and those that are not. It continues to kill the untreated prey and leaves the treated prey alone. Thus, to be effective, the chemical or system has to be applied constantly to every animal in need of protection. Or, worse yet, the predator habituates to whatever has been applied to repel attack and continues to attack both treated and untreated prey. Occasionally, when salient cues such as bells are used to enhance the repellent effect of some cue, such as chilli pepper, once habituation occures, the predator can use that cue to find prey. In that case, losses may increase.

In contrast, the purpose of applied CTA is to establish strong aversions for the taste of ordinary beef or mutton. In that case, every cow or sheep is protected from attack by any animal that has acquired a taste aversion from eating treated cattle or sheep carcasses. Because the predator cannot detect the chemical used to produce illness during feeding, they do not acquire any gustatory or olfactory cues to help them discriminate between tasty beef and bad-tasting beef. Let us examine some of the pros and cons of applied CTA.

Pros:
Inexpensive
Safe for humans
Non-lethal to consumers
No Negative Environmental Impact
Long-lasting
Compatible with most husbandry methods
Trained territorial predators "protect" livestock

Cons:
Taste specific
Not an overnight solution
Human factors, logistical and political
Misapplication not neutral
Incompatible with lethal predator removal

Proper application of CTA requires only a small investment in training and the will to conduct applications properly. As stated above, misapplications will result in *more* losses than if the method is not used at all. Materials that are required for application are carcasses of the prey species that is being lost. Although previous research with canids found that bait packets made from minced meat wrapped in pieces of hide were effective, my preliminary work with large felids has suggested that they have a strong preference for whole meat presentation. Therefore, I recommend using only carcasses (or pieces of carcass) for application to felids. The chemical of choice to date, in applications to predators, is still lithium chloride (LiCl). This chemical has a number of advantages. It is relatively inexpensive. It is quite safe for humans to handle. The margin of safety between an effective dose and a lethal dose (the therapeutic index) is high. It can be stored indefinitely. It is ubiquitous in soil, ground water and sea water. I have found that the highest dose that produced one-trial aversions in canids (500 mg/kg body weight) may not produce rapid aversions in felids. Several trials may be required. Heavy-gauge needles and large (60 cc) syringes are used to treat the prey carcass with a solution of LiCl (no more than 10 grams LiCl dissolved in each 1 liter of clean water). *Wait until the solution cools before beginning application.* LiCl is a dessicant, so rubber gloves may be helpful in reducing skin irritation. An entire dose of LiCl solution must be injected into each meal-sized piece of carcass. In a typical cow carcass, hundreds of injections are required, as only 3 cc of solution should be delivered to each injection site. If the target predator is nocturnal, carcasses should be covered with brush to minimize consumption by diurnal birds and other wildlife.

Application is not a once in a lifetime endeavor. Like any other method of husbandry and management, it requires consistency. Applications should be made in anticipation of periods when predator losses will be highest due to females feeding young, lambing or calving seasons, etc. Every effort should be made to treat or dispose of any carcass. Untreated carcasses are free food and will only teach inexperienced predators to develop a taste for livestock. Combine the application of CTA with the use of traditional methods, such as herding and the use of guard dogs, donkeys or llamas.

Summary of Dos and Don't s

Dos:
Be consistent
Be meticulous
Train assistants personally
Treat after EACH kill
Treat meal-sized amounts
Disperse pieces for multiple predators
Use rubber gloves
Use DILUTE LiCl solution
Mix solution until cool
Inject 2-3 cc solution/site
Treat each species killed
Use solution immediately if in plastic container
Store crystals in dry, sealed container
Calculate approximate doses

Don't s:
Don't be haphazard
Don't be sloppy
Don't rely on verbal instruction
Don't leave free food
Don't treat too much/too little meat
Don't encourage sharing
Don't taint carcass with human scent
Don't use CONCENTRATED LiCl solution
Don't inject while solution is warm
Don't inject large amounts in each injection site
Don't treat beef carcasses to reduce sheep losses
Don't store LiCl solution in plastic containers
Don't store LiCl crystals in open container
Don't guess at doses

Taste aversive conditioning: a comment

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In this issue of CDP News Forthman presents a review of conditioned taste aversion CTA which does an excellent job of explaining the conceptual background to the method, and reports the results of successful trials in captivity. Based on the abundant research on the topic there is no doubt that CTA can be achieved for a wide range of species under captive conditions. However, we have major reservations about the applicability of the methodology under field conditions in Europe. It should be pointed out that CTA research related to reducing livestock depredation has been ongoing since the early 1970's in both the laboratory and the field. During this period a huge number of trials have been conducted. The majority of these trials have failed to document any significant effects, and to the best of our knowledge, CTA has never been adopted as a regular management tool because of its failure to work. Objections can be grouped into three main categories (1) Conceptual, (2) Practical and (3) Unknown side effects.

(1) Conceptual problems. Most successful trials have managed to induce an aversion to eating a specific carcass following a negative experience of eating a treated carcass. However, in the context of depredation reduction it requires that the predator should stop killing a certain type of prey following a negative experience with eating a carcass of the same prey. Much evidence indicates that cues which release killing behaviour differ from those that release eating behaviour. Therefore it is not automatic that aversion to eating livestock will reduce the killing of livestock. Forthman argues that a predator is unlikely to waste energy in killing a prey that it knows it will not like to eat. However, livestock require very little energy to kill, and field studies for most predators