Extinction

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## Abstract

Detection dogs are often expected to generalize recognition from training samples to wild samples while maintaining specificity to a given target category. Since dogs are often used to locate targets that are visually challenging to identify, their continued specificity is important in deployment. While best practices exist for training and maintaining specificity in detection dogs, little is known about regaining target specificity if false alerts occur frequently. This case study focuses on the training of two experienced conservation detection dogs, owned by Action for Cheetahs in Kenya, that were making consistent false alerts to off-target caracal (Caracal caracal) and leopard (Panthera pardus) scat samples during training to detect cheetah (Acinonyx jubatus) scats. Previous attempts to reduce false alerts in training, including no-reward markers and time-outs, had not reduced false alerts over time. Procedures for handling, acquisition, and storage of target and off-target samples were refined prior to implementing the extinction protocol. These two dogs were trained using an extinction procedure to reduce false alerts to caracal and leopard scats while maintaining sensitivity to novel cheetah scats. Both dogs exhibited an extinction burst within four training sessions, demonstrated by an increase and then decrease in the number and duration of false alerts. Following the initial extinction burst, both dogs performed fewer false alerts for the duration of the training program. All training was conducted by novice handlers from Action for Cheetahs in Kenya under the guidance of expert trainers in-situ in Samburu County, Kenya. Sessions were filmed and coded for false alerts, true alerts, and when possible, misses and correct dismissals. In line with best practices for early stages of detection dog training, most training was not performed blind to facilitate response times between the handler and the dog. In later stages, handlers were blind to scat locations. These results demonstrate that it is possible to reduce false alerts in operational detection dogs via extinction paired with systematic reinforcement of desired alert behavior. This case study also highlights the importance of record-keeping and careful handling protocols for training samples.

## Introduction

Conservation detection dogs are specially trained to sniff out odors related to conservation. They work similarly to bomb, drug, or Search and Rescue dogs – but instead of searching for accelerants, drugs, or missing people, they search for targets related to ecological research or conservation biology. Many targets are difficult for humans to see, find, or observe, but dogs can sniff out these data while remaining non-invasive, effective, and efficient (Grimm-Seyfarth et al., 2021). To find these targets, such as scat or carcasses, dogs learn to associate finding the target odor with a reward, such as their favorite food or toy. Action for Cheetahs in Kenya (ACK) is part of a non-profit organization that uses conservation detection dogs to sniff out cheetah scat. After the scat is found, it is sent to a lab where it can be analyzed to learn about cheetah health, populations, prey selection, and many more data points. It can be difficult for a human to differentiate between scat from cheetahs and scat from other predators. In past visual searches conducted by ACK staff, only 27 of 262 (10.3%) putative cheetah scats were confirmed by genetic analysis (Mutoro et al., 2022). Because organizations must pay per sample that is analyzed, it is costly and inefficient to analyze samples that are not cheetah scat. ACK employs two conservation detection dogs, named Madi and Persi. They were previously trained to find cheetah scat, then sit in order to communicate to their human counterpart that they found a target. During training sessions, other non-target odors are sometimes presented to “proof” the dogs off of them. In other words, similar odors, such as scat from other cats or carnivores, are presented in order to teach and ensure that the dogs are alerting only to cheetah scat (the “target”) and not to “non-target” sources of odor. Some of these similar but non-target odors include scat from leopard, lion, and caracal. During practice searches in 2021, it was discovered that Madi and Persi were alerting to some of these non-target scats. It is unknown exactly when or how this began, but it is likely that they were rewarded for some time for finding these non-target scats.

## Methods

### Subjects

Two detection dogs owned and trained by ACK. Madi was a six-year-old male border collie/Rottweiler mix with roughly five years of experience as a cheetah scat detection dog, including during the National Cheetah Survey. Persi was a three-year-old female Belgian malinois with over two years of training completed. She had not yet been deployed in an operational capacity, largely due to the COVID-19 pandemic, but she had significant field trial experience. Over the years, the dogs had been exposed to many handlers, trainers, and training approaches. Both dogs were trained to sit and stare at a target scat when found. During this study, ACK staff included two novice dog handlers, hereafter handlers. Both were in their first professional role as dog handlers and trainers with less than six months of experience in this position. ACK staff were the primary trainers and data collectors. K9 Conservationists team members designed the protocol, hid the scats, and coded the videos. The K9 Conservationists team includes three trainers, hereafter trainers, each with at least 2 years of experience training detection dogs and with at least 5 years of experience professionally training dogs for a variety of applications.

### Materials and Study Area

Most training took place at two different training areas in the ACK field station in Meibae Community Conservancy, Samburu, Kenya. Area 1 was an open sandy area bordered by shrubs, roughly 10m x 20m, with cut-off 2L soda bottles partially buried in the sand. Scats could be placed inside of the 2L soda bottles or on the ground within the search area. Area 2 was roughly 20m x 25m with shrubs, two roughly perpendicular 30-cm deep gullies, rocks, and other vegetative matter sparsely mixed throughout the area. In both areas, rocks, shrubs, vegetative matter, and other camp materials were occasionally used to visually obscure scats. In later stages of training, the dogs were also trained in area or linear searches. These took place around camp in search areas measured in square meters (area search) or minutes walked down a road (linear search). Dogs were primarily trained off-leash, though later training introduced leash handling. Scat location in area searches was marked on a handheld GPS unit. The trainer walked to areas other than the scat placement and touched other items such as rocks or branches to reduce the likelihood of the dog tracking the assistant to the scat. Training sessions were recorded using mobile phones for analysis.

### History-Taking

Prior to the commencement of any training protocol, the team conducted investigations into the history of the problem. Training record notebooks had been lost or contained incomplete notes. Similarly, organizational knowledge regarding the starting point of the off-target alerts was lost due to staff turnover. It was gathered that the dogs had been making off-target alerts for at least a few months. The ACK team handled off-target alerts in training with verbal redirection (“No, search on”), given in a neutral tone of voice. The goal of this approach was to function as a no-reward marker and reduce false alerts in the future. If the dog made a subsequent off-target alert, the training session was paused for a minimum of two minutes and the dog was returned to the kennel. Over several months of this approach, the number of false alerts per session had not noticeably decreased. The dogs had a very strong learning history of sitting and staring at their targets. The bulk of their recent training had focused on alert training rather than seeking and sourcing odor or discriminating between targets. Following the Humane Hierarchy (Friedman 2009), it was confirmed that the dogs were not suffering from any health concerns that may impact their ability to perform the task, such as a respiratory illness that reduced their olfactory sensitivity. At this point, the team developed several potential explanations for the off-target alert behavior:

Samples were contaminated with the odor of plastic and/or each other due to storage in plastic containers and in close proximity to each other without odor-proof barriers (see Hallowell et al., 1997). Plastic containers were washed and re-used without remaining species-specific. Because plastic is odorous and odor-permeable, samples were likely cross-contaminated (Goss 2019). Furthermore, samples were air-dried in a closed room with off- and on-target samples only separated by approximately 1m. This increased the risk of cross-contamination. Caracal, leopard, and cheetah scat samples were so similar in odor profile that discrimination between the samples required additional, specialized training. A fundamental odor saliency issue was deemed unlikely due to the dogs’ history of discriminating between off-target and cheetah scats in field surveys and training. However, the dogs’ behavior was consistent with variable schedules of reinforcement for all scat samples rather than discriminating between two species. This may be a result of training always including exactly one target and exactly one off-target, creating a 2-alternate forced choice scenario. The handlers were inadvertently cueing the dogs to alert to off-target samples by inadvertently indicating their presence to the dog in a variation of the effect demonstrated in Lit 2011. In this case, rather than the handlers leading the dog to an off-target alert due to being misled by an experimenter, the handlers could be leading the dog to an off-target alert by hesitating or hovering near an off-target sample to see if the dog would make an error. The dogs had learned that the most expedient way to earn their reward was to alert to the first sample encountered, regardless of its odor profile, because the handler would give them feedback on their response immediately. We hypothesized that it was less cognitively challenging for the dogs to make a guess and adjust based on the response than it was for them to perform the discriminative task. Given that their chances of encountering the cheetah scat first were 50/50, it was more expedient to “guess.”

Given the limited time that the trainers had in Kenya (about 13 weeks total), it was determined that our approach would focus on sample acquisition and storage first, then an extinction protocol to address false alerts.

### Sample Acquisition

To address the sample contamination concern, we started by disposing of all old samples and containers. All new samples were air-dried outdoors in designated on- and off-target areas separated by at least 10m. They were then placed in new containers and stored with at least 3 barriers between on- and off-target samples (eg, sample CH1-A inside of a plastic bag inside a plastic container for individual CH1 inside of a larger plastic container for all cheetah samples). Plastic bags and new plastic storage containers were used despite permeability and odor concerns with plastic due to the lack of availability of glass or mylar containers in rural Kenya (see Goss 2019 for a discussion on the downsides of plastic storage). All samples were handled with gloves and were discarded after 3 months of use or if contamination was suspected. Best practices support discarding and replacing samples more frequently, but this was not practical due to the limited availability of species-confirmed scat. Scat bags were labeled and a reference sheet marked the scat identification code, species, individual, age, sex, source, date collected, and any notes regarding the sample.

### Training Procedure

The dogs were trained one at a time with an average of 4.84 repetitions per session (minimum 1, maximum 8, 51 sessions total). On a given repetition, the trainer first started the video recording from a mobile phone on a tripod. The trainer said out loud the date, time of day, samples used, dog, and handler and then placed out one cheetah scat sample and one off-target scat sample (leopard or caracal). The handler was instructed to stand on an X in the sand with their hands behind their back. The handler and the trainer were not consistently blinded in training sessions. In testing, blinding or double-blinding is imperative to reduce the chance of “Clever Hans” effects. However, in realistic training scenarios, the handler often knows the location of the target to set up a search strategy appropriate for the level of expertise of the dog. It was important that our training strategy remain attainable for the ACK team in our absence and be repeatable for single-person detection dog outfits in the future, and therefore chose not to blind the handler. However, as training progressed to linear and area searches, the handler searched blind while the trainer followed (single-blind approach). Linear and area searches were conducted off-leash with the handler following at least 2m behind the dog, except for June 9 trials where leash handling was introduced. From the handler’s starting position, the dog was told to search and directed toward the search area with a single hand point. The handlers were instructed not to move or speak. The trainer used a handheld clicker to mark the moment that the dog performed its alert (sitting and staring at the target scat), and then the dog returned to the handler for toy play and praise. In the event of an off-target alert, both handler and trainer were to stay quiet and still until the dog dismissed the off-target scat and made a correct alert. Both handlers were warned of the concept of an extinction burst; that the intensity, duration, or number of false alerts would likely increase before decreasing (Muething et al., 2024). Based on the expert opinion of the trainer, some training repetitions strayed from this basic setup. In several instances (n=3, Persi), the dogs were exposed to a search area with only cheetah scat (no off-target scats) to ensure success. This was done after Persi had multiple false alerts to an off-target scat and then did not alert to any scats for a repetition, checking both species but not making a decision. In order to rebuild the alert, a few repetitions without an off-target scat were deemed necessary. Occasionally the trainer elected to click (mark) and reward the dog for sniffing the correct scat rather than waiting for a full alert (n= 2, Persi). A few repetitions also included handler errors on the timing or criteria of the click and were removed from the analysis (n=2, Madi). In one repetition Madi attempted to mouth the scat and was verbally corrected (the trainer said “ah-ah” loudly). The trainer interrupted one false alert for Madi, which lasted 600 seconds and Madi was starting to fall asleep. That repetition was followed by one successful repetition and the session ended early. See the full training records in Supplementary Materials. Persi overall received more training repetitions than Madi (Madi n=93, Persi n=145) partially due to an injury for Madi and partially due to her higher stamina and strong drive to work for her reinforcers.

### Video Analysis

The trainers coded all videos of sessions for correct and false alert numbers and duration to prepare for the next training session. For video coding purposes and analysis, the following definitions were used:

| Correct.Alert | False.Alert | Correct.Dismissal | Miss | False.Alert.Duration |
| --- | --- | --- | --- | --- |
| The dog sits at the cheetah scat | The dog sits at a non-cheetah scat. If the dog takes steps away and then returns, count as a separate false alert. Readjusting a sit, standing and staring, and other interactions with a scat during an alert event all count as one alert until the dog steps away; then count as a separate alert if the dog returns. | The dog sniffs a non-cheetah scat and does not alert. The dog’s nose must drop to indicate sniffing; passing by without a sniff is not a dismissal. | The dog sniffs a cheetah scat without alerting. If the dog never checks a scat (runs right past it or never approaches), that is NOT marked as a miss. | The duration in seconds from when a dog sits to when a dog takes steps away from a scat. Mark the freeze-frame when the dog is in half-sit at the start and end of an alert. Count as the end of an alert if after standing the dog steps away from the scat. If the dog readjusts its sit or continues to stand at a scat, count seconds until the dog actually leaves the scat as one alert. |
|  |  |  |  |  |

For an example video of Persi making a false alert and then hearing a click at the moment of a correct alert, please see the Supplementary Materials. Trainers reviewed video and used timestamps and the definitions above to determine the training program progress and assess the plan for the next day.

### Data Analysis

The extinction protocol explained above was utilized from May 9 - June 7. Training with the teams continued after June 7, however methods changed in order to progress training, so the analysis is primarily limited to before June 7. A brief summary of results from continued training is also included. Data was cleaned and analyzed using R. A link to the repository can be found in Supplementary Materials.

## Results

Utilizing the extinction methodology, both dogs showed decreased numbers and durations of false alerts over time. It was expected that each dog would experience an extinction burst (Muething et al., 2024), then show decreased false alerts. False alerts were measured in quantity by number and in duration by seconds and can be shown over time by day (session) or repetition number. One session consisted of multiple repetitions. Because sessions were not consistent over time, dates were converted to ordinal numbers called session number.

Between the dates of May 9 and June 7 2022, Persi underwent 15 days of training, which contained a total of 149 repetitions. Figure 1 shows the number of false alerts per repetition by Persi over the course of sessions (each session consisting of 1-8 repetitions).