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Case Study

Wildlife detection dog training: A case study on achieving generalization between target odor variations while retaining specificity

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ABSTRACT

Wildlife detection dogs are required to correctly discriminate target wildlife species odor from nontarget species odors (specificity), while enabling some degree of target odor variation (generality). Because there is no standardized training protocol, and little knowledge on training efficiency, we conducted a case study to test a dog's training efficiency in detecting 2-week-old wild otter (*Lutra lutra*) feces (spraint) odor among feces odors from 6 other large mammal species that often share the otter's natural habitat, including fox (*Vulpes vulpes*), hare (*Lepus europaeus*), roe deer (*Capreolus capreolus*), and cattle (*Bos taurus*). The dog was trained using a standard multiple-choice carrousel in a stepwise protocol. We started with odor samples from fresh captive otter spraints and progressed toward 2-week-old spraints from wild otters among other mammalian dung odors and tested for specificity and generality after each training step. We show that training on only 2 variations of spraints from captive otters enabled the dog to detect all desired spraint odor variations in our protocol, indicating a rapid generalization to variations of spraint odor the dog was not trained on, while retaining specificity. Testing such concept formation of target odors should be included in detection dog training and certification and could serve as a quality control measure of detection dog performance.

Introduction

Wildlife detection dogs can be trained to identify traces of target animals and their scats (de Oliveira et al., 2012; Wasser et al., 2012; Browne et al., 2015). The dogs are often required to correctly discriminate target wildlife species dung odor from nontarget species dung odors within the same habitat (specificity), while enabling some degree of target odor variation such as caused by diet or age of the target species (generality). The goal of the training of wildlife detection dogs is concept formation: the dogs learn to respond to odors similar to those used in training, based on recognizing common odor components of the particular target wildlife species. Although this is often called generalization (Oxley and Waggoner, 2009; Lazarowski and Dorman, 2014), strictly speaking generalization is an accidental outcome of a learning situation [the tendency for stimuli similar to the original stimulus to produce the response originally acquired (Ghirlanda and Enquist, 2003; Reber et al., 2009)], and not the intended outcome. Concept formation, leading to identical responses to different sources or variations of target odor, is often assumed (Cablk and Heaton, 2006), but our literature review did not reveal a systematic assessment to check detection dogs on this point during their training. The few published studies in this field indicate (1) that dogs do not respond to all desired target odor variations if there is insufficient variety in training aids (Oxley and Waggoner, 2009) and (2) that several variations of target odor training are necessary to enhance generalization and thus promote the formation of a concept (Fischer-Tenhagen et al., 2011; Oxley and Waggoner, 2009). However, a step-by-step assessment of this process has not been conducted before.

Our study was designed to systematically train a detection dog to discriminate an increasingly complex set of target odor variations from decoy odors from scats of 6 other mammal species and to

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systematically assess its tendency to generalize target odors. The goal of the training was for the dog to respond to a spraint (otter scat) as it would be found in nature: from wild otters, slightly degraded through outdoor aging. We first trained the dog on fresh captive otter spraints and tested its response to 3 scat age levels (from fresh, through aged 1 week to aged 2 weeks) and then to diet at 2 levels (from captive to wild) combined with 3 age levels, that is, 6 target scent variations in total. After each step of the training, specificity was tested against decoy samples, and the level of generalization was tested by offering unfamiliar spraint samples.

Methodology

Design, dog, target odors, training carrousel, and responses

The study was designed to train the dog progressively to sniff out 2-week-old target odors amidst decoy odors and to test progress at each step (Figure 1). The dog's tendency to generalize was assessed in 3 tests. During training with each target odor variation, test 1 was conducted to see if the dog generalized to a similar spraint of the same odor variation but from another animal. If yes, test 2 was conducted to see if she could detect 2-week-old spraint from a wild otter. If so, test 3 was carried out to confirm concept formation by including all available target and decoy odors. On failing a test, the training was picked up at the point where it had failed.

We used a female Malinois of 12 years old, keen to hunt and search for detecting objects with human scent in the field. Spraints (scats) from 3 groups of seafood-fed captive otters (housed separately) were collected in Natuurpark Lelystad, a Dutch nature education facility. Wild otter spraints were collected on multiple locations in the Dutch nature reserve Weerribben-Wieden, where animals consumed fresh water fish (Leonards et al., 1997). Like in a scent-discrimination experiment, we used a 6-arm multiple-choice carrousel (Schoon and Haak, 2002; Schoon et al., 2014) in a training facility to train and test the dog, making use of blanks, target, and decoy samples. The dog's response to each and every odor sample or blank in the carrousel was individually recorded and classified in a 2 × 2 confusion matrix as either true positive (alert, target odor present), true negative (no alert, target odor not present), false positive (alert, target odor not present), or false negative (no alert, target odor present).

Decoy odors and preparation of samples

Six feces odors were chosen as decoys during training and testing, selected for their occurrence in Dutch nature reserves and their tendency to distract dogs. They were feces of fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*), hare (*Lepus europaeus*), roe deer (*Capreolus capreolus*), cattle (*Bos taurus*), and horse (*Equus ferus caballus*). For each species, feces samples were collected from multiple locations to ensure variability. Like the target odor, the decoy odors varied in age; fresh, 1-week-old and 2-week-old samples were available for each decoy odor.

All fecal samples for target and decoy odors were collected and handled with plastic gloves. Only fresh samples were collected, stored in plastic containers, individually labeled, and kept in clean trays in a freezer, separated by species. A number of fecal samples of each species were stored separately outdoors underneath a shelter for aging 1 week or 2 weeks, respectively, on which they were frozen and stored too. Frozen feces samples were cut into small, thin slices of approximately 1 cm^2 before training or testing. This enabled reuse of the same frozen sample without additional degradation and contamination issues (*cf.* Browne et al., 2015 and

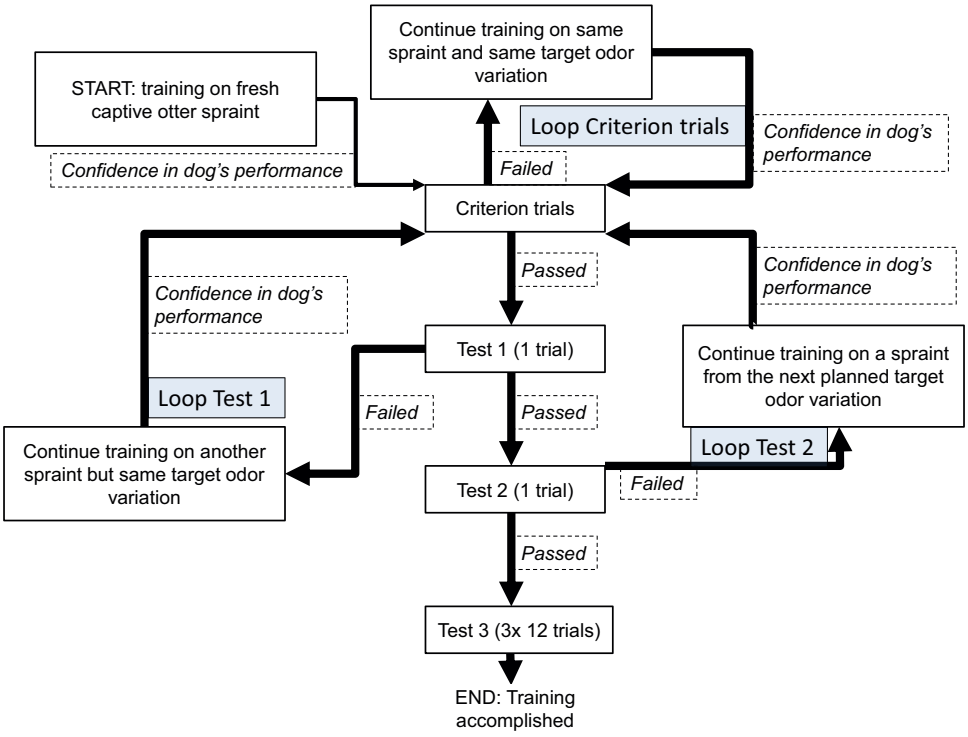

Figure 1. Flowchart of the designed schedule for training and testing detection dog generality and specificity. Training started with fresh captive otter spraint. Criterion trials were done if there was confidence in the dog's performance. If the dog did not pass the 5/6 criterion, training continued with the same spraint of the same target odor variation (loop criterion trails). If the 5/6 criterion was passed, the experiment continued with test 1. If test 1 was not successful, training continued with a different spraint from the same target odor variation (loop test 1). If test 1 was successful, the experiment continued with test 2. If test 2 was not successful, training continued with a spraint from the next planned target odor variation (loop test 2). If test 2 was successful, the experiment concluded with test 3. The sequence of target odor variations was as follows: fresh captive otter spraint > 1-week-old captive otter spraint > 2-week-old captive otter spraint > fresh wild otter spraint > 1-week-old wild otter spraint > 2-week-old wild otter spraint.