



## Performance decline by search dogs in repetitive tasks, and mitigation strategies



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### ARTICLE INFO

#### Article history:

Available online 1 March 2015

#### Keywords:

Canine  
Detection  
Extinction  
Vigilance  
Learned inattention  
Olfaction

### ABSTRACT

Differences between training and working contexts have the potential to be a major cause of deficits in performance of searching animals. Detection responses of individuals trained with high rates of target stimulus presentation tend to extinguish when moved to a new context where their rate of target encountering is low. This problem is acute with some contraband and people detection dogs where the rate of target encountering in the work context is significantly lower than during training. While the rate of extinction can be mitigated by planting known targets in the working contexts, this is often logistically difficult, dangerous, or impractical; an alternative solution would therefore be beneficial. Here, we explore the novel approach of adding non-contraband target stimuli to the training set and then presenting these innocuous targets periodically in the work context, thereby avoiding the logistic difficulties attached to the use of real contraband targets. Our rationale is that the search persistence caused by the innocuous targets could generalise to the real targets, thus increasing resistance to extinction in the latter. The potential problem with this approach is that dogs may learn to focus on the innocuous targets in the work context to the detriment of the real targets. In our experiments, 21 dogs were trained with three contraband (explosive) and one innocuous (non-explosive) odours. When they were transferred to a “work” context, they were separated into three groups, as follows: Group “OT” (zero target) were not exposed to any targets in the work environment; Group 1T (one target) were exposed to and rewarded on one innocuous target in the work environment; and Group 3T (three target) were exposed to and rewarded on three contraband targets in the work location. These regimens continued for six weeks during which time all dogs received two refresher training days away from their work location, where they were rewarded on all four target odours. Following this work phase, search and detection performance was tested in the work location for all stimuli. In the work phase, search vigilance in the OT group dropped considerably compared with the 1T and 3T groups. Critically, when dogs were re-exposed to all four targets in the work location at the end of the work phase, detection rates were significantly reduced for the OT group, but were maintained on all targets for the 1T

*Abbreviations:* SDD, scent detecting dogs; NE, non-explosive; DR, detection rate.

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<http://dx.doi.org/10.1016/j.applanim.2015.02.013>

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and 3T group. Our results show that rewarding search persistence with innocuous stimuli is potentially a successful strategy to maintain detection-dog performance across a range of trained contraband odours.

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## 1. Introduction

Scent-detecting dogs (SDDs) are used for a wide range of detection tasks from searching for lost people to the detection of contraband goods such as drugs, firearms and explosives. Trained dogs are highly adept at showing response behaviours to a range of targets, but evidence suggests that performance may be hampered in locations where dogs are required to repeatedly search the same location without encountering any targets (Gazit et al., 2005). This study aims to investigate this location specific problem.

Scent detection dogs are trained using operant conditioning to create a stimulus-response chain of searching, locating an odour and giving a specific “indication” response, typically a sit orientated towards to odour source. The behaviour chain is initiated by a range of physical, contextual (environmental) and verbal cues such as having a harness put on, being at a training location and being instructed to search by their handler, all of which act as discriminative stimuli for the search behaviour. Encountering the target odour during a search acts as a secondary reinforcer for the search behaviour and also as a discriminative stimulus for the indication response, which is ultimately reinforced by play with a toy or by food.

A robust finding in the literature on animal behaviour is that that the target response of well-trained animals undergoes extinction (a decline in response over time) when response behaviours are not reinforced in the presence of a previously conditioned stimulus (e.g., Rescorla, 2001). Since the body of work produced by Pavlov (1927), experimental observations of the extinction effect are abundant in the literature (for reviews see, for example, Mackintosh, 1974; Rescorla, 2001; Bouton and Woods, 2008; Bouton et al., 2011; Bouton et al., 2012). There is substantial evidence that animals do not lose their associative memories during extinction, but instead form new competing associations; extinction is therefore a form of learning, rather than unlearning (e.g., Bouton and Woods, 2008). Bouton and colleagues outline how context is critically important in extinction; since new associations are learned during extinction (i.e., that there is no unconditioned stimulus (US) following the previously conditioned stimulus (CS)), the context acts as an occasion setter to enable to animal to recall the correct US-CS association at a later date (Bouton and Woods, 2008). This enables an animal to show no response behaviour in the extinction context whilst maintaining the response behaviour in other contexts. While the majority of research on extinction has been conducted on classical conditioning, Bouton et al. (2012) provide evidence that instrumental (operant) extinction also involves new learning and is also largely context dependent.

In the case of SDDs, there can be contextual differences between training and working; for example, venues and routines often differ between the two and handlers may unconsciously act differently in training and operational scenarios. It can be expected that these differences would allow dogs to easily discriminate between the two scenarios which may result in a generalisation decrement in the non-training context (e.g., Mackintosh, 1974). These differences are addressed through a range of approaches by the detection dog training community, for example, dogs are trained in a wide range of environments to reduce or eliminate any effect of new environments *per se*, however some differences are likely to be impossible to eliminate such as unconscious differences in handler behaviour.

The majority of detection dogs encounter high target densities during both training and working, any contextual differences between the environments are therefore largely irrelevant as the response behaviour is equally reinforced in each context. However, for a small proportion of dogs the target density encountered during work is significantly lower than that encountered during training. In this scenario, the differences in work and training contexts may be expected to result in degradation of search thoroughness and detection rate in the work context where dogs are not regularly given the chance to complete the behavior chain and receive reinforcement, while original associations and behaviours are retained in the target rich training.

This effect of performance degradation in a low target density context was reported in explosive detection dogs by Gazit et al. (2005) who showed that dogs rapidly discriminated between two similar search areas where one contained target odours and one did not. Dogs showed slower search speed in a target-free area compared to a target-rich area and a novel area. Importantly, the detection rate when targets were reintroduced was commensurately lower in the (formerly) target-free context than the (formerly) target-rich and novel-search areas. Any such discrimination between training and working locations for operational SDDs should be of considerable concern for agencies using dogs for detection.

One way to decrease or even eliminate any decline in SDD search behaviour due to extinction is to reward the animal for the target indication behaviour using planted stimuli in the work context. However, for working dogs, this can require the placement of contraband in areas where contraband is not permitted; this is logistically difficult and often impracticable. An alternative solution which we explore here is to train dogs to indicate on one innocuous non-contraband odour in addition to their target odours. This would make it easier to plant training targets in the working context. This training strategy however is untested and potentially inefficient: dogs may

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