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Canine scent detection—Fact or fiction?

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ABSTRACT

Dogs have been used in a variety of scent detection tasks for hundreds of years. However, methodological differences in the design of studies concerning canine scent detection make it difficult to directly compare and to evaluate their results. We set out to (1) evaluate the quality and comparability of published literature concerning canine scent detection according to criteria of evidence-based medicine and (2) to determine the influence of the testing system on the outcome of a scent detection task considering two different testing systems. For the systematic literature evaluation we retrieved 31 studies. After applying specific exclusion criteria 14 studies were left for final evaluation. A check list detailing relevant information about the study design and the training and testing process was used. Our results demonstrate many differences in methodology and a high variability of the results of those studies leading to diversity in respect to relevant quality criteria. For the second part of our study seven dogs were trained by means of positive reinforcement to detect black tea (LIPTON Earl Gray, Unilever Deutschland GmbH, Hamburg, Germany) as target scent in two different testing systems, a testing platform and a scent detection board. Our data show that using an optimized training strategy high sensitivity (92.1%) and specificity (97.4%) can be achieved in a short time. Sensitivity and specificity for the detection of a target substance (i.e. black tea) was similar for the two testing systems.

1. Introduction

Dogs have a highly sensitive olfactory system and therefore been used in a variety of scent detection tasks for hundreds of years. There are many reports mostly of anecdotal evidence about the "amazing scent detection abilities" of trained dogs. In most cases, however, objective data on test characteristics of the scent detection performance of those dogs were not presented. Therefore the quality and validity of those reports are questionable. Today the most important and frequent applications are detection of explosives and land mines for police and military (Gazit and Terkel, 2003). Recently, several applications in human medicine (e.g. cancer, diabetes) have been described and tested (Moser and McCulloch, 2010) and it is speculated that the importance will increase considerably. There are many other scent detection applications for which dogs were used (Browne et al., 2006) and where studies have been conducted to evaluate their reliability, e.g. indication of toxic contamination of the environment (Arner et al., 1986), illicit discharge polluting habits (Reynolds et al., 2008) and mold formation and other microbial growth in houses (Kauhanen et al., 2002). Trained dogs can also contribute to the protection of endangered animal species by detecting their feces and identify individual animals by scent matching (Kerley, 2010) or by detecting animals in their natural habitats (Cablk and Heaton, 2006). The dog's olfactory capabilities were also used in elimination of pests, such as rodents (Gsell et al., 2010) or screwworms (Welch, 1990). In dairy research, dogs have been trained to identify estrus specific odors in different body fluids (Kiddy et al., 1978; Hawk et al., 1984; Kiddy et al., 1984; Fischer-Tenhagen et al., 2011).

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Evaluating the scent detection capability of dogs is challenging. On one hand dogs are able to notice hidden clues (i.e. unconscious reactions of the trainer), known as the "Clever Hans" effect (Moll, 1904). On the other hand dogs can easily recognize individual samples instead of searching for the target scent. As it takes only 1–2 s for a dog to determine the direction of an odor trail made by the footsteps of the person hiding the target (Hepper and Wells, 2005) it is possible that a dog simply follows those traces instead of performing a free search for the target.

Methodological differences in the design of studies concerning canine scent detection make it hard to directly compare and to evaluate their results. For determining accuracy or sensitivity and specificity of canine scent detection different testing strategies were used in previous studies, such as the free search for the target scent in a defined area (Paula et al., 2011), a differentiation task in which the dogs had to find a positive sample between negative samples (Richards et al., 2008), a special testing platform (Fischer-Tenhagen et al., 2011), a multiple-choice apparatus (Fjellanger et al., 2002) or a skinner box (Göth et al., 2003). Usually, trainers and handlers judge their dogs' ability to perform certain scent detection tasks as high and flawless. There is a dearth of science-based information, however, on test characteristics of dogs as a diagnostic test for the target scent eliminating hidden clues or other hints. Considering the wide variety of training and testing methods and the diversity of publications the overall objective of this study was twofold: first, to systematically evaluate the quality and comparability of published literature concerning canine scent detection according to criteria of evidence-based veterinary medicine. Secondly, to determine the influence of the testing system on the outcome of a scent detection task considering two different testing systems.

2. Materials and methods

2.1. Literature evaluation

A systematic literature research was conducted on 5th June 2012 using the databases Pubmed (www.pubmed.gov) and CAB (http://ovidsp.tx.ovid.com) to find studies concerning scent detection work in dogs. The subject headings "scent" AND "detection" AND "dogs" were used to find articles written in English or German language about training dogs for specific scent detection tasks. In a supplementary hand search additional publications were recruited. We excluded duplicates, systematic reviews without original data and papers that did not include canine scent detection training. The remaining articles were evaluated using a check list detailing relevant information about the study design and the training and testing process. Specifically, we recorded quality criteria of the analyzed studies, such as detailed description of dog training, number of dogs and percentage of dogs finishing the training process, training duration, blinding of the dog trainer and other personnel toward the sample position in testing, random placement of samples in testing, use of new samples in testing mode and type of task (differentiation vs. free search). Retrieval and management of references was performed with Endnote (Version X4 for Windows, Thomson Reuters, New York, USA).

Fig. 1. German Jagdterrier indicating the positive sample on the training platform.

2.2. Own study

2.2.1. Dogs

Seven privately owned pet dogs (two female Labrador retrievers, one and six years old, both spayed; a female Berger de Pyrénées, six years old; a female German Jagdterrier, six years old; a male Border collie, one year old; a male Bernese mountain dog, six months old and a female Shepherd cross-breed, nine years old) were enrolled.

All dogs had previously been trained to detect at least one target substance (e.g. dried chamomile) by scent on the training platform. Of the seven dogs, three had previously been trained to detect at least one target substance by scent on the scent detection board.

2.2.2. Training laboratory

Training and testing took place in an indoor laboratory at the Nordiska Hund training center, Kälarne, Sweden, using a training platform (Fig. 1) and a scent detection board (Fig. 2) as special training devices. We decided to use the platform as first testing system because it had been already used by our group previously with good success (Fischer-Tenhagen et al., 2011). The scent detection

Fig. 2. Labrador retriever indicating the positive sample on the scent detection board.