Project no
E63162
Client
The Swedish Police Authority
FoT-område
Vapen och skydd

Authors
Lina Mörén, Håkan Wingfors, Mona Brantlind, Fredrik Bergström, Hanna Ellis, Erik Holmgren and Helena Hansson Halsius

Date
2021-12-10
Memo Number
FOI Memo 7855

Canine responses to explosive training materials affected by storage conditions

1 Background

Explosives detection dogs are among the most effective and useful sensors for detecting explosives. Dogs are trained to recognize volatile compounds of relevance to explosive materials and in most cases small samples of explosives are used, although the use of synthetic samples have been reported. The samples are usually stored in sealed containers to avoid contamination with other materials but no investigations have been found describing the integrity of scent profiles over time nor whether they are representative of scent profiles found during realistic conditions.

The aim of the present two-year aging study was to increase the understanding of changes in chemically analysed scent profiles over time from ten explosives and one reference material composed of pure DMNB, which is a commonly used as taggant. Results from the chemical characterisation was then compared to data received when trained dogs were tested on scents representing materials of different storage time. The materials included are presented in **Table 1**. 10 g of each material was stored openly during the two-year period (aged material) and 10 g was stored in sealed containers (non-aged material).

Table 1. Materials included in the study.

Material	Type	Dominant compounds	Taggant
ANFO	Granules	Ammonium nitrate	-
Dynamite	Plastic explosive	EGDN/AN	-
C4	Plastic explosive	RDX	DMNB
Pentyl plastic explosive	Plastic explosive	PETN	DMNB
NC	Granules	Nitrocellulose	-
Trinitrotoluene	Flakes	TNT	-
Hexotol (Comp B)	Granules	RDX/TNT	-
Octol	Granules	HMX/TNT	-
DMNB	Granules	DMNB	-
TATP	Crystals	TATP	-
HMTD	Crystals	HMTD	-

The present memo only describes the method and results of the practical dog-training test. It should be regarded as a complement to a submitted manuscript “Rapid changes in profiles from stored materials used in scent training for explosives detection dogs”[1], which describes the method and results of the chemical analysis of explosives scent profiles in full.

[1] Mörén L., Bergström F., Brantlind M., Wingfors H. Rapid changes in profiles from stored materials used in scent training of explosive detection dogs. Submitted manuscript 2022-03-18

2 Method

For safety reasons it was decided that the homemade explosives TATP and HMTD were excluded from the dog training tests.

2.1 Baseline test

The baseline competency test consisted of a semi-circle with eight containers following test methods developed by the bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) in the US. Each container held a fresh and unaged explosive material or an interfering substance (a distractor). The baseline test was performed six months prior to the final dog tests. The aim was to verify that the dogs recognised and alerted to all materials included in the study.

2.2 Recognition test

The recognition test was used to evaluate if dogs recognize materials stored at different time periods (see **Figure 1A)**. It consisted of ten metal containers and glass jars placed in a semi-circle. Another, smaller, glass jar containing the test material (explosive or distractor) (10 g), was placed inside each jar, see **Figure 1C**. The larger glass jar which had a perforated lid, was then sealed, see **Figure 1B**. The dogs searched the semi-circle from left to right. The time from the materials being placed along the path until the first dog started to search was 60 minutes. Six teams composed of dog and handler performed the recognition test each day. They first searched over the aged material three times and then three times over the non-aged material. The position of the explosives varied according to a pre-determined order and the dog handlers were blind to the presence and locations of potential targets. The dogs were only allowed one attempt per lap. Two blank searches, with jars containing distractors, were carried out each day to verify that the dogs did not respond to background noise or distractors. One or two distractors were replaced when a new explosive material was either entered or removed.

The containers were placed in the same order during each day. Position 1, 9 and 10 never contained a material as errors are more frequent at the end of the path, and the risk that the dog fails to search is usually greater for the first container of the path. Upon alert, the dogs were only rewarded by vocal praise or patting, **Figure 1D**. The starting order varied every day. Five materials were used during the first week and four during the second week. In total, there were twelve dog and handler teams, six per week. Daily measurements of room temperature and humidity showed small variations of 18-22°C and 40-50 % RH, respectively.

All searches were filmed and later evaluated to identify potential increases in intensity and excitement when the dogs searched over a material. Notes were taken during the search regarding whether the dog showed interest to test objects by residing, sniffing or unnoticeably alerted to a jar or failed to search a specific jar.

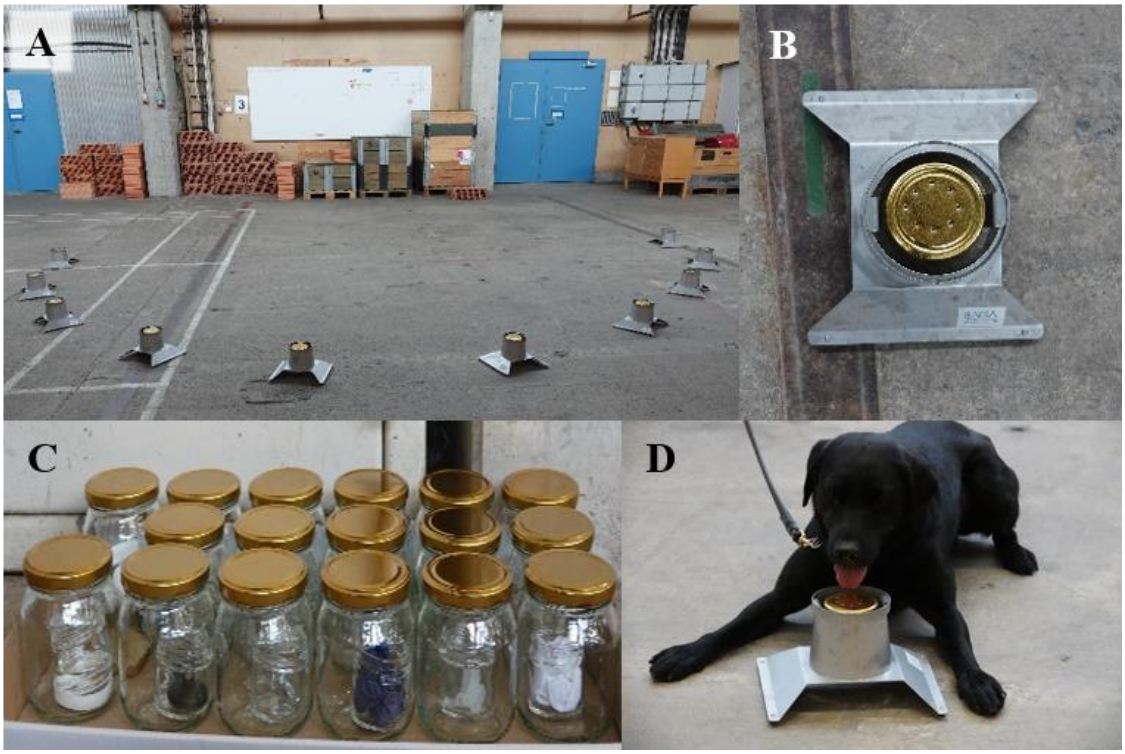

Figure 1. A) The selection path with ten containers **B)** A jar containing an interfering substance or a material was placed inside the container. The jar was sealed and the metal lid was perforated. **C)** Four types of interfering substances were used, 45 jars in total. **D)** Each dog performed eight searches per day.

2.2.1 Operational search

The operational test was performed as searches of stashes in a warehouse. Every day, one of the nine materials were tested in a different aisle, see **Figure 2 A**. Three samples of the aged material were placed on the left-hand side of the aisle and three samples of the non- aged material were placed on the right-hand side. Empty jars were put in place to verify that the dogs did not alert or respond to scents from the glass jar or scents associated to the handling of jars. All stashes were placed at the front edge of the shelves, from the floor up to a height of 1.5 metres (to the second shelf), see **Figure 2 B-C**. The stashes with aged material were identical to the stashes with non-aged material. To the greatest extent possible, the stashes were located to allow the dog to sniff inside/beside the jar containing a material. None of the stashes were visual for the dog handlers. The time from placement of the materials until the first dog started to search was 60 minutes. Five materials were tested the first week and four during the second week.

In total, there were twelve dog and handler teams, six per week. The starting order varied every day. The searches lasted between 12 and 20 minutes. The handler decided how the search was to be carried out in the aisle and the dogs were allowed to search the shelves back and forward. The purpose of the test was to, as far as possible, resemble an operational search. Upon alert the dogs were only rewarded by vocal praise or patting.

During the two test weeks, relatively stable temperatures of ~21 °C in the warehouse was measured and the relative humidity was about 50 %. All searches were filmed and later evaluated to identify potential increases in intensity or excitement when the dogs searched near a stash. Notes were taken during the search regarding whether the dog showed an interest in a stash by residing, alerting or failing to search in the vicinity of the stash.

Figure 2. A) The warehouse and the aisles where the searches were carried out. **B)** Stash in a cardboard box containing material, open or slightly covered. The dogs were unable to search inside the box. **C)** Open stash behind the pallet block, on the floor or 1.5 metre up.

3 Results

3.1 Baseline test

The results of the baseline test showed that all dogs were able to detect all materials included in the study.

3.2 Recognition test

The results showed a significant difference in dogs' responses between materials that had been aged and non-aged materials that had been stored in a sealed container during the study period. This difference was observed in both search intensity and number of alerts. A total of 432 searches were carried out. A few incorrect alert (false positive) was registered and errors mainly occurred for the last jar at position 10.

3.3 Operational search

A total of 54 searches were performed, equalling 324 chances to find and alert to aged and non-aged materials. Only a few incorrect alerts were registered, although not for the glass jars that were used as distractors. Some materials required the dog to search directly over the stash in order to detect it, whereas others emitted an elevated scent profile making them detectable from a distance. The results of the operational search showed a significant difference in response to aged and non-aged materials with regard to search intensity and number of correct alerts. **Figure 3** illustrates dogs searching and alerting.

Figure 3. Operational search in a warehouse.

4 Discussion and conclusions

Whereas results from chemical analyses of scent profiles captured above materials are easily interpreted, implications of the finding that dogs respond differently to new and aged explosive materials are more difficult to predict. However, based on findings that scent profiles change relatively quickly during aging, it is reasonable to assume that this is also the case during authentic and realistic conditions. Overall, with the significant differences in dogs' responses for aged and non-aged materials it is advisable to complement dog training with scent profiles covering various stages of the ageing cycle. This could contribute to an improved utility and accuracy of detection dogs and, in turn, a safer society.