TECHNICAL REPORT NO. 71-11

# EXPLOSIVES DETECTING DOGS

Final Report

By
Max Krauss
Biological Sciences Branch



September 1971



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## ABSTRACT

A feasibility study was undertaken to determine whether dogs can be trained to discriminate the odors of commercial dynamite (straight nitroglycerin dynamite and ammonium nitrate dynamite), black powder and the plastic explosives, C3 and C4. Initial discrimination training established hexachloroethane as a practical surrogate odor. Transfer to the various explosives proved relatively easy. Search behavior, both on- and off-leash appropriate for searching buildings, was developed. At the conclusion of the effort, five trained dogs were delivered to the Land Warfare Laboratory.

## FOREWORD

The work described in this report was performed as a part of the LWL Task, Explosives Detecting Dogs, under Contract No. DAAD05-70-C-0347 with the University of Mississippi. Most of the work described here was done at the University of Mississippi. The program was funded in part by the Law Enforcement Assistance Administration of the Department of Justice. Two of the dogs that were delivered to the Land Warfare Laboratory were in turn delivered to LEAA.

Special acknowledgment is due to personnel of the U. S. Naval Explosive Ordnance Disposal Facility, Naval Ordnance Station, at Indian Head, Maryland, whose wholehearted and enthusiastic interest and cooperation, combined with their high technical competence, made it possible to set up realistic training exercises for the dogs and their handlers.

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## I. INTRODUCTION

The continuing military need for an effective real-time capability to detect concealed battlefield threats such as ambushes, buried or camouflaged land mines and other explosive ordnance devices, etc., has been met in part in the Vietnam war by the use of specially trained dogs. Scout dogs, mine/booby-trap/trip wire detecting dogs and tunnel detecting dogs, have proven highly effective in operational use in Southeast Asia. An obvious extrapolation of the sensory perception capability of canines, as demonstrated in Vietnam, is to the detection of concealed explosives and bombs in civil as well as military settings. A study, which is described in the following pages, was therefore undertaken to determine the feasibility of training dogs to detect explosives such as dynamite, black powder, C4, etc.

## II. CONCLUSIONS

1. It is possible to train dogs to discriminate small amounts of commercial dynamite (straight nitroglycerin dynamite and ammonium nitrate dynamite), black powder and the plastic explosives, C3 and C4.

2. It is feasible to employ dogs trained to discriminate the odors of various explosives to search a building for concealed bombs.

3. A detection rate of 70 percent to 80 percent by a trained dog in building search for concealed explosives is readily attainable.

## III. MATERIALS AND METHODS

A. Dogs. Five German Shepherds and three Black Labrador Retrievers were procured for this study. Seven of the eight dogs were females, which were spayed. All of the dogs were de-barked. Initially, the dogs were housed in a boarding kennel and given obedience training by an obedience school.

B. Facilities. Dog kennels were prepared and a storage magazine for small quantities of high explosives was constructed. Various buildings, including the entire University of Mississippi physical plant, the football stadium, a warehouse, and some vacant dormitory buildings were made available for use in training.

C. Explosives. Commercial dynamite, including straight nitroglycerin dynamite and ammonium nitrate dynamite, black powder, and the plastic explosives, C3 and C4, were all eventually obtained and used in the training program. Preliminary discrimination and search training utilized hexachloroethane as the odor stimulus source. Hexachloroethane is a volatile solid that evaporates completely without leaving a residue. It proved to be a convenient material for use in this study.

D. Training Methods. Traditional obedience training was started soon after each dog was purchased. It soon became evident, however, that certain aspects of this training would be likely to hamper detection and search training. Thus, voluntary search behavior tends to be inhibited in obedience training, and this training also develops an undesirable degree of orientation to the handler.

An interesting alternative to traditional obedience training was investigated with one male German Shepherd which was not one of the experimental animals. This dog was food-deprived and the commands SIT, STAND, HERE, DOWN, and STAY were established in approximately five hours. According to a professional dog trainer, twenty-five hours are typically required to train a dog in these behaviors using traditional training procedures. The individual who trained this dog had been given instructions in the utilization of operant learning principles in dog training but was not assisted in the actual training.

1. Secondary reinforcement training. The weights of all dogs at the beginning of detection training were at approximately 80 percent of their original weights. Although there was some individual variation, these weights remained at about this deprivation level for the next 30 days. The dogs were approximately 24-hours food-deprived at the time of training.

In order to condition praise as a secondary reinforcer, the daily ration of food was always paired with praise. Training was also given to establish hexachloroethane, the odorous material used in initial detection training, as a secondary reinforcer. In this procedure the dog was given food and praise in the presence of the S+ odor and not rewarded if the odor was not present. In the first session, either a bottle containing the odor or an empty bottle was taken to the dog, which was tethered on an outside run. In the second session of trials the dog was taken to a stationary bottle which was empty on some trials and contained S+ on some trials.

2. Training of sitting, searching and sniffing. Special training of the SIT command was given with food combined with praise as the reward. Essentially this training consisted of giving the dog the verbal SIT command either when the dog was directly beside the handler or a few feet from him. If the dog sat to the verbal command, he was immediately given praise and food as reward. If the dog did not sit, the command was repeated.

The technique used to instill sitting and searching was that of "shaping" the behaviors by a gradual increase in the difficulty of the search and detection task. Later detections, in general, required more intense sniffing and searching behavior, and, on the average, required a longer trial time.

Early in training, in order to establish the command SEARCH as a cue for searching and sniffing, the handler gave this command upon entering the room and subsequently always gave the same command when the dog was very close to the odor bottle. This latter command, however, was given in an urgent tone and was often repeated. Later in training, the command SEARCH was less frequently given in the immediate vicinity of S+. This procedure appeared to be very effective. The dog immediately intensified his sniffing and searching behavior when given this command. There also seemed to be other behaviors, such as tail wagging, which seemed to be elicited by this command.

After the search behavior was established, the sit response to the odor was continued, using a multiple-choice situation. The dog was taken to each of four bottles in turn. When an orienting response was made to the bottle containing the odor, the dog was placed in the sitting position and was then given praise and food. This training continued for two days, after which the SIT contingency was incorporated into the room search.

3. Transfer from hexachloroethane to dynamite. The transfer from hexachloroethane to dynamite odor was made as follows: First, all dogs were given training to establish dynamite odor as a secondary reinforcer, by pairing the dynamite with food. Second, the dogs were trained to sit to dynamite in a simple discrimination situation. The initial phase of discrimination training consisted of a two-choice discrimination task in which S+ was a small amount of the surrogate odor combined with a large quantity of the new odor. The quantity of the surrogate odor was gradually reduced over trials until the dog eventually responded to the new odor alone. Subsequently, multiple-choice discrimination tasks with dynamite were employed.

In the room-search situation, the same basic procedure was used. The two odors, in combination, were planted. The quantity of the surrogate odor was gradually decreased until only the dynamite was present. Once the initial transfer to dynamite had been made, further training with dynamite was carried out in a variety of situations. Transfer to the other explosives was accomplished in the same way.

4. Handler training and simulated operational exercises. The last month of this study was spent at Aberdeen Proving Ground, Maryland, and at the U. S. Naval Explosive Ordnance Disposal Facility at Indian Head, Maryland. At Aberdeen Proving Ground four handlers (two police officers

from the New York City Police Department, and two NCO's from the U. S. Army Military Police School, Fort Gordon, Georgia) were given training in the handling techniques that had been developed. The latter part of the period at Indian Head was devoted to final testing in realistic simulated operational building search exercises. The personnel at Indian Head were most cooperative. In addition to preparing simulated bombs with which to test the dogs, they presented informative talks and films on the nature and handling of explosive materials. During the evaluation of the dogs, the members of the demolition corps hid the simulated bombs, directed the handlers, and kept records of the performance of the dogs and handlers.

## IV. RESULTS

Five trained dogs (3 German Shepherds and 2 Black Labrador Retrievers) were delivered to the Land Warfare Laboratory at the conclusion of the training effort. These dogs could each discriminate the specified explosives plus the surrogate odor of hexachloroethane. Each of the dogs was also capable of searching rooms and areas within a building, either on- or off-leash and detecting less than 1/2 ounce quantities of each explosive concealed in packages of various configurations.

During the final training sessions at the Naval Ordnance Disposal Facility at Indian Head, Maryland, realistic pipe bombs containing 1/4 pound to 1/2 pound black powder, and packages containing 3 to 5 sticks of dynamite were used as targets in building searches. Overall detection rate averaged for all dogs was of the order of 70 to 80 percent.

## V. DISCUSSION

The present study has demonstrated that it is feasible to use trained dogs to detect various explosives hidden in buildings. Very little has been said about the role of the handler. Perhaps the handler's most important functions are to maintain his dog in a high state of readiness and to provide his dog with sufficient motivation to perform its job effectively. Secondarily, the handler must be able to guide his dog in search and direct its attention, if need be, to areas and/or objects of interest. It should not be the handler's duty to plan and/or supervise a building search; this should be done by another member of the team.

In order to perform his functions adequately, the handler must have some knowledge of basic principles of behavior and of learning. He must understand the elementary mechanics of both operant and classical

conditioning. It is particularly important for the handler to understand the motivational basis of learned behavior (as distinguished from instinctive behavior). The handler should be sufficiently alert at all times to detect the beginning of any breakdown in his dog's detection and search behavior. He should be aware of the possible consequences, in terms of extinguishing both wanted and unwanted behaviors, of any conditioning process he may initiate. Sometimes a conditioning process is initiated without the handler being aware of it until there is a gross change in his dog's behavior. The handler should then be capable of analyzing the influences that have caused the change and of taking appropriate remedial action. As a part of the present contractual requirements, a handler's guide and a training manual have been compiled.

Maintaining a learned behavior, such as search for explosives, at an acceptable level of proficiency requires that a schedule of motivating reinforcement be developed and employed on a regular basis. This is particularly important when operational goal achievement, i.e., finding an explosive in a real search, occurs only intermittently, if at all. Maintenance search and detection exercises must, therefore, be conducted regularly throughout the operational life of a detector dog. Additionally, search motivation can be maintained in operational searches if surrogate plants are made for the dog to find in order that it may receive reinforcement. With the use of surrogate plants, a dog can be kept at a high level of motivation for extended periods of time in search.

The selection of handlers is a problem that is outside the scope of this study. It should be obvious, however, that handler selection is a critical factor in the ultimate success or failure of the explosives detector dog concept. The man-dog interface is an extremely delicate area in which the slightest, most subtle variations, even in the handler's mood, may be reflected in his dog's performance. Criteria for handler selection need to be developed specifically for detector dog teams; these may be quite different for handler criteria for police dog teams, for example.

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