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A STUDY IN TRAINING METHODOLOGY OF MINE DOGS

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An attempt was made to organize the training of mine dogs into logical learning segments: object discrimination, outgoing excursion, and search. The procedure for object discrimination learning alone failed to produce the desired result. A possible alternative method is suggested and briefly described.

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PREFACE

This study was funded by the USA Mobility Equipment Research and Development Command (MERDC). At the request of the Military Dog Detachment, USAIS, the US Army Land Warfare Laboratory undertook the task of modifying mine dog training methods for the purpose of obtaining greater simplicity and economy in the production of the system. USA MERDC planned to evaluate the mine dogs of this study. Training was performed at Fort Benning, Georgia by personnel of the Military Dog Detachment under the technical direction and supervision of the author.

TABLE OF CONTENTS

INTRODUCTION

During World War II, the US Army trained mine dogs by aversive control methods. Mines and trip wires became occasions for avoidance responding after they were repeatedly paired with foot traps and electrified grids. Avoidance responses were defines as sit or lie-down from one to four paces distant from the mine location; halt and refusal to advance in the case of trip wires and surprise firing devices. The one evident contingency in the training method, namely, stop forward movement in the presence of explosive devices to avoid a painful consequence, raises a serious control problem for the trainer when strong ancillary emplacement cues such as disturbed earth, disturbed vegetation odors, and residual human scent become associated with the primary explosive artifacts. The dog thus may receive an earlier warning of possible presence of the explosive devices somewhere nearby. As conditioned fear stimuli, the emplacement-related cues may also become occasions for responding. Avoidance responding to them would thereby significantly reduce the chances of locating the more distant explosive devices, or of even determining if such devices are actually present. It is doubtful that another aversive contingency could be arranged to strengthen the outward movement response in the presence of emplacement odors - the emplacement odors then would not evoke the detection response, but only aid in locating the exact position of ordnance devices present if search continued.

A not uncommon effect of arranged aversive contingencies is impaired behavior which is likened to "helplessness". During severe emotional stress, the dog simply quits working even in the face of "threats" and physical pain. Further, the entire field setting could become so aversive to some dogs that they would refuse to move out at all in the tactical situation.

More recently in response to an urgent combat requirement in Southeast Asia, the US Army Land Warfare Laboratory developed a new mine dog system. The principal behavior controlling feature of the system was positive reinforcement in the form of food with petting and praise. The "reward" method overcame some of the problems posed by the forced control technique. In an operational test and evaluation, the dogs were successful in locating numerous hazardous devices. Some dogs even detected caches, hidden ground cavities and humans in ambush, even though they were not specifically trained to do so.

The criteria of dog performance which was subsequently established for the operational mine dog system was as follows:

(a) Operates off-leash 50 to 100 meters in front of the handler.

(b) Locates buried mines, hanging mines up to five feet above ground, surprise firing devices, and openings to ground cavities, all up to ten feet upwind of the dog's path.

(c) Obtains a detection proficiency of 80 percent under simulated tactical conditions.

(d) Sits within two feet laterally of the target's position.

(e) Responds to trip wires that are between one-half inch and 48 inches above ground by sitting within two feet of them.

(f) Travels without guidance along a trail or road, and operates under the direction of the handler's arm and hand signals in open areas.

(g) Moves outward in the desired direction at a rate compatible with the immediate tactical requirement, which is about two to three km/hr.

(h) Works with more than one handler.

(i) Is capable of working for two continuous hours.

Although numbers of mine dogs became operational in the Vietnam conflict, the methods by which they are trained remained almost unchanged, even though it was generally felt that improved methods were required both to increase the speed of learning and to improve performance reliability.

The present study centered on the development of methodologies for object discrimination training, test of object discrimination, search, and outward movement. By the prevailing procedure, all component skills of the mine dog system were arranged to be learned simultaneously, with learning complexity gradually increased until the entire system was shaped. For considerations of simplicity and economy, changes in method were made to obtain learning of each component skill independently of any other.

In object discrimination training, the dog learned the meaning of odors which were foreign to the immediate environment, and to detect them at near-liminal intensity levels under varied means of comouflage. The work was accomplished in an experimentally controlled setting. Concurrently, sessions were conducted in an operational type of setting in which the dog learned to move outward at the proper speed and to travel a predetermined distance. Outward movement was then combined with search training in which the dog learned to identify environmental odor cues that signalled the nearby presence of ordnance devices. The dog also learned how to use the wind and scent cone effectively to locate target objects. Finally, daily tests of object discrimination were made in an operational type of setting under the same conditions of target object concealment that were used in object discrimination training during earlier sessions. The training procedures by which the sit response, discriminatory sniffing and search chain behavior were developed have been fully described elsewhere.[1]

[1] Romba, J.J. Remote Control of War Dogs: Remotely Controlled Scout Dog. LWL Technical Report No. 74-78. June 1974.

OBJECT DISCRIMINATION

The validity of a discrimination procedure is determined by the capacity of that procedure to establish stimulus control over a selected response. Stimulus control is established when a response is emitted in the presence of a set of stimuli and is not emitted in its absence. At the time of the system's development, mine and tunnel detection training appeared to be a discrimination procedure for the presence of complex stimulus configurations called mines, surprise firing devices and ground cavities. There is, however, such a great variety of US and foreign mines and related devices, manufactured and handmade, that discrimination training to even a small number of them would not be practical. Also, the materials which make up the ordnance and related objects, such as metals, plastics, fibers, preservative coatings and seals, and explosive compounds are not sufficient common to ordnance objects in general to make any of them good candidates for discrimination training. Nevertheless, the dogs were given experience with some representative mine-related components and a variety of defused mines of domestic and foreign origin. The standard non-mine object used in training was a wire-enclosed "cricket cage", which contained mine components. The amounts and kinds of materials enclosed in any container randomly varies. Thus, the mine-finding strategy to be learned by the dogs was left to chance.

From the nature of mine-locating errors made by the dogs during the periods of testing and evaluation, it became clear that most dogs used mine-finding strategies that did not utilize the odors of mines or of mine-related components specifically. Instead, most dogs learned to respond to ancillary cues such as residual human scent and to disturbed earth and vegetation, rather than to odors associated with the explosive artifacts per se. Typically, the reception of emplacement-related odors was followed by search for their source. The dog then sat where the accessory odors were the strongest. This strategy was confirmed when the dog sat where the accessory odors were present but where target artifacts (mines) were not, or at places where the target objects were known to be concealed too thoroughly or buried too deeply to be detectable. Using this strategy, a dog will miss very few mines in its path, but on the other hand it will give frequent false responses. The evidence from observation suggests a dog confronted with a mine concealed to such a degree that it is effectively not detectable learns to treat the so-called emplacement stimuli as the discriminative stimuli for the sit response. The limit of a dog's sensitivity for detecting a small, plastic antipersonnel mine (M14) appears to be attained when this mine is buried under ½ inch of compacted soil overburden under normal weathering[2] conditions of several months, or under 2 inches of loose granular soil. The strategy as described requires only that the animal search for places where accessory emplacement odors originate. No mine artifacts or any related materials then are needed to accomplish training.

[2] Romba, J.J. Ability of Specialized Mine Detector Dogs to Find Mines in an Aged Mine Field at APG. LWL Tech Note No.71-02. Sept 1971.

Some dogs used a second kind of mine-finding strategy. These dogs also followed odors associated with mine-emplacement to their source. There they confirmed the presence or absence of any object or material which was foreign to the surrounding medium. They sat at buried objects which were not necessarily mines or related components, and moved on in the absence of any foreign substance. Sit responses were also likely to occur at foreign objects where no accessory, emplacement cues were present, and at places where stagnant air emanated from ground cavities. False responses were rarely made in the presence of accessory cues alone, but the dogs also failed to indicate the presence of mines under some conditions of concealment. The employment of this strategy was verified in several trained mine dogs when they sat at such buried objects as cigarette packs, empty milk cartons, etc., in addition to varied ordnance objects, and continued in outward movement when no foreign objects were present. Since current training methods are geared toward obtaining a detection response to the presence of military objects, learning of the latter strategy only is incorporated in the methodology of the present study.

Object Discrimination Training

An attempt was made to insure a higher probability of responding in the presence of mine-related stimuli than in the presence of all other stimuli, in situations where both sets of stimuli were always arranged side by side. Essentially, the dog could sample the odors at adjacent positive and negative plots simply by standing in one place and moving its head from one side to another.

The experimental 2-position discrimination procedure differs from the prevailing method in the following:

(a) It provides immediate feedback about reinforcer availability in the presence of mine-related odors, and its non-availability in the presence of all other odors.

(b) It is not inextricably combined with the learning of other system skills.

(c) It provides many more learning trials in a shorter period of time.

(d) It permits working many dogs over the same programmed setting. Human and dog odors which contaminate the programmed field in the prevailing procedure after a single trial run by only one dog, do not become differentially associated with either one or the other sets of odors stimuli in the experimental procedure of this study.

Method

Ten trails, each 60 meters long, were cut from one uniformly dense brush area. They were laid out parallel to one another and about 20 meters apart. Ten 2-position discrimination problems were arranged for each trail. Two experimental plots of ground, each of which measured approximately 2.25 sq ft, were set side by side and were outlined on the ground by a frame made of wood dowels. One plot contained a target stimulus object and one did not.

Each pair of the discrimination plots was separated from another pair on a trail by about 4 meters. All plot coverings were alike so that the only differentiation between plots was the presence or absence of mine-related target objects.

The character of mine emplacement was systematically varied during training. It included such variables as depth of burial, degree of concealment and duration of emplacement. The soil composition within the plots was either sandy loam, gravel or sand. The thickness of soil over the target object was never more than ½ inch, compacted or 1 inch, loose. As training progressed the target stimuli, which initially were emplaced in full view of the dog, were gradually faded out of sight. The only non-mine stimuli that was also associated with reinforcement was a camouflaged ground cavity, the odors from which could diffuse to the surface of the ground. The duration of target object emplacement ranged from 2 hours to 2 weeks. No attempt was made to control the moisture content of the surrounding medium.

Conditioning of mine-related stimuli was accomplished by the use of Pavlovian methods, i.e., particular stimuli came to forecast the imminent appearance of food after having been repeatedly paired with other conditioned stimuli that also led to food. Before stimulus conditioning was undertaken, a sniffing response was required. Sniffing was brought under control when the dog learned that on specified occasions, sniffing of an object for at least three seconds was followed by food. Stimulus discrimination then came about when sniffing mine-related odors was associated with food and sniffing of other odors was not.

In a typical trial run, a dog was led to a discrimination setting. When the dog stopped at the edge of the dowel frame, the trainer walked to the other side of the paired discrimination plots and faced the dog. The dog then sampled odors from the two adjacent plots. If sniffing lasted for at least 3 seconds in the positive plot, the trainer said GOOD and reached into his food pouch for a morsel of food to give to the dog. After the dog ate the food, a second pairing of object odors and food was given at the same plot, then the dog was led to another discrimination setting about 10 feet away where the procedure was repeated. After the run was completed, trials were administered in the reverse direction. In this manner, 40 pairing were made. Usually, a second session was conducted in another similarly programmed field so that a given dog would have about 80 trials. During initial training sessions, when the dog was becoming accustomed to the trial procedure, the target object was totally visible to the dog on top of the ground. The significance of the non-mine related odors (not paired with food) became more apparent when the target object was concealed from view.

Testing Object Discrimination

Stimulus discrimination and testing stimulus learning were conducted in tandem sessions. Whenever satisfactory detection proficiency was demonstrated under particular concealment conditions in the twin plot discrimination setting, the same conditions were programmed in an operational type of setting. This involved transfer of learning from one environmental setting to another. By the time this testing was performed, the dog already knew how to move about in an open field and how to utilize ancillary odor cues for locating emplaced mines.

Method

The dogs were run on training trails 300 and 500 meters long. From none to as many as 6 search and detection problems were programmed on a trail. An exposed target object was always placed at the end of a trail so that the dog could make a sit response and receive final reinforcement. If a dog missed a mine emplacement situation it was not corrected, but was permitted to continue along the trail. It was assumed that in such cases, the dog did not perceive the presence of either ancillary odors or odors from the target object. It was reasoned that a hungry dog will not pass up a food reinforcing situation if it recognizes it as such. Only 1 dog was run on any given trail because dogs leave strong odor cues that can identify to other dogs the location of programmed target objects.

LEARNING CORRECT OUTWARD MOVEMENT

The correct behavior topography of outgoing movement is not efficiently accomplished if only reinforcing mine situations draw the dogs outward. Where mines are potentially present, the dogs learn to proceed cautiously ahead with frequent stops to investigate the surroundings. Forward progress at a rate of 2 to 3 km/hr can be readily obtained when adequate reinforcement is made for a predetermined distance of travel.

Method

A trial began when the dog at the heel position was given the command MOVE and was terminated when the dog reached a reinforcing object in full view on the trail nearby. The ratio of work output per unit of food reinforcement, where work was measured in distance travelled, was gradually increased until an operational work criterion was met. Roads and trails helped to keep the dog in bounds while long distance travel was shaped. Dogs came to depend on distant environmental stimuli, such as prominent features in their visual field, to control the direction of excursions across open fields.

When a dog predictably moved out on a trail or road for a distance of at least 500 meters, it was placed on an alternative schedule of reinforcement, i.e., it received food either for sitting in the presence of mine targets or for travel over a predetermined distance.

SEARCH TRAINING

Early exploratory work showed that dogs could not detect odors from mines alone when they were lying on the ground but hidden by grass or light brush, unless they passed within two feet of them. Other evidence indicated that the limit of a dog's sensitivity for detecting buried mines in one-half inch of compact soil overburden under normal weathering conditions of several months, two inches of loose sandy loam overburden, or five inches of loose sand cover - provided also that the dog's nose is in contact with the earth surface at the burial site.

Actually, the dog does not need have to scan every inch of ground to be effective. Its typical behavior in the field is forward movement usually at a steady pace of 2-3 km/hr, with occasional random exploratory activity which is not target-related. Target search begins when the dog is stimulated by odors which are associated with target emplacement or by odors of the targets themselves. The most significant of the emplacement-associated odors are disturbed vegetation, disturbed earth, and human "dead scent". When these stimuli are perceived, the dog moves upwind, then it appears to utilize the leading edge of the scent cone to close in on the odor source. It is there at the accessory odor source that the dog makes a determination that if a target mine is buried or not. If no part of an object is visible, the dog sometimes aids the confirmation process by pawing at the earth in the vicinity of the potential target location.

In the event that the dog goes into search behavior, intensely explores at a particular location, then moves on, the dog handler can mark the position as a potential target site, because a target may be present but is too deeply buried for detection. The effectiveness of a dog's performance will then depend on its ability to employ target emplacement cues in its search strategy. Many dogs do not naturally know how to locate a point odor source so that special training was directed toward the development of effective search strategy by the mine dog.

Method

A cricket cage, containing a variety of materials associated with mines and related objects, served as a mine simulant during search training. The reinforced response was to sniff the object for at least 3 seconds and then to sit next to it. At first, the cricket cage was placed in plain view along the dog's path. Then, the dog learned to associate several mine emplacement-related odors with the presence of mines. The first odor of this type that was learned was the human "dead scent." This odor was paired with the mine odors either by laying the mine object over a folded, perspiration-soaked undershirt or by placing the object over the place where the trainer sat for 1 minute. Stimuli pairings were made increasingly farther off the trail as the dog became proficient in its search behavior.

The next odor that was learned was that from recently disturbed earth. Target object odors were paired with loose earth odors by placing the object on top of a bit of loosened sandy loam. Finally, the odor of disturbed vegetation was learned by placing the target object in a clump of crushed grass or other vegetation. If the disturbed vegetation was above ground, the target object was hung next to it in full view. Conditioning of the latter two ancillary odors continued according to the procedure used in human odor learning. Human odors were present to some degree in all pairing trials.

The role of emplacement odors was defined in a discrimination procedure that was undertaken next. Until this stage of training, the target object was always present. In the current step, the ancillary odors were programmed without the target object being present in some trials. The emplacement odors continued to serve as an occasion for the initiation and continuation of search, but no longer as the occasion for sitting. Sitting in the absence of target objects was ignored by the trainer as he continued to move on past the animal. Target misses were not corrected because it was assumed that in such cases the dog did not smell any emplacement or mine-related odors.

RESULTS AND DISCUSSION

The current method of training mine dogs attempts to develop the required diverse mine dog behaviors almost simultaneously in an operational type of scenario. The demands on the dog in all behavior areas increase progressively until an operational system is finally shaped. The method is both inefficient and ineffective, at least in some respects, because the animal's attention is channeled only to some of the programmed reinforcement contingencies available.

The present study sought to improve on the prevailing training method by separating the system skills into smaller learning segments and then combining them into an operational system.

Training outgoing movement brought about control over a sequence of behaviors that begins at heel, followed by leaving the heel position, continuing in outgoing movement ahead of the trainer and terminating in an outward excursion of approximately 1/3 mile on a trail or 200 meters across an open field. Forward progress usually was at a rate of 4 to 6 km/hr.

The ability of a dog to utilize wind direction and scent cone factors to search out odor sources is learned. Thus, search training is an essential element in the total program if a dog is to achieve proficiency in mine finding. Dogs used in the present study showed a steady increase in the speed with which they were able to locate off-trail objects.

Object discrimination training produced mixed results. The general consensus of trainers in the program was that the procedure as described in this report was fatiguing to the trainer and difficult to manage properly. Temporary breakdowns in the test behavior topography occasionally occured, probably mainly because of trainer failures. Imprecise timing of reinforcement and cueing the dog before reinforcement were the principal failures. Lack of adequate experimental data concerning some of the behavior-controlling variables in the setting also contributed to breakdown of the behavior.

The search for a workable alternative training procedure in which object discrimination learning is accomplished in a controlled environment is worthwhile if only because it allows for many trials to be given in a short time and for many dogs to be worked in a given programmed field. A procedure that merits serious consideration is one known as a method of successive discrimination. Positive and negative stimuli are presented one at a time rather than in a simultaneous pairing of both types of stimuli. In this procedure, well-defined stimulus plots would be established in a linear sequence at intervals of about 10 ft. A dog would go from plot to plot and examine each of them for the presence of foreign objects. When an object was detected, a sit response at that plot would be reinforced. The same plots could be reused for the training of many dogs if a simple precaution were taken to prevent the dogs from using the odors where preceding dogs had sat to identify the mine-containing plots. This could be done by having a number of dogs sit at each plot before training sessions began. The present study was terminated before work along this line could be undertaken.

CONCLUSIONS

In the present study, failure to produce fully trained mine dogs was due largely to the presence of uncontrolled variables during the learning of object discrimination.

It appears that mine detector dogs can be effectively trained by procedures that essentially result in the accumulation of individually learned behavior segments.

RECOMMENDATION

Further work should be undertaken to explore alternative training procedures such as the method of successive discrimination.