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# TRAINING DOGS FOR EXPLOSIVES DETECTION

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By
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13. ABSTRACT

A feasibility study was undertaken to determine whether dogs can be trained to discriminate the odor 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.

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# INTRODUCTION

Bomb threats and the actual destruction of life and property by bombings have increased in recent years; coping with them has become an important responsibility of law enforcement agencies. In order to assist these agencies in adequately carrying out this increasingly important responsibility, methods have been developed for the training and use of explosive detector dogs.

Several advantages are inherent in the use of dogs to detect explosives. First, dogs can detect minute amounts of odor from explosive substances that man cannot detect. Second, they can be trained to detect and respond to several different kinds of explosive odors. Third, they can be trained to search an area more quickly and efficiently than a man. A further advantage of the dog is that since it relies primarily on odor cues, it can detect explosive devices in boxes, baggage, furniture, and other places of concealment, and it can make the detection without having to enter these objects and places, thus greatly decreasing the danger of detonating concealed explosive devices in the course of a search.

Considering these advantages, it is obvious that a good explosive detector dog and a well-trained handler can search out explosives much more rapidly and efficiently than a man alone. A detector dog can be a valuable asset in bomb detection work, and this manual is designed to describe, in a step-by-step fashion, how to train a dog efficiently to search out and respond to specific explosives.

## SELECTION OF DOGS

The most important factor in beginning a detector dog project is the correct selection of dogs for the project. Although there has been no conclusive demonstration that any particular breed of dog is best suited for detection work, the Canine Behavior Laboratory of the University of Maryland recommends German Shepherds and Labrador Retrievers as having a good combination of sensory capacities and temperament.

This manual is based on procedures developed during the training of dogs to detect odors from explosive materials. Eight dogs were used for the pilot training project. There were three Labrador Retrievers and five German Shepherds, but the results of the training project do not justify recommending one breed over the other. A dog's individual temperament is more important as a selection criterion than its breed.

Every dog selected for explosive detection training should meet certain physical and temperamental standards. The following is a list of these standards:

Physical Standards.

1. Free of distemper, infectious canine hepatitis, leptospirosis, mange, heart worms, rabies, ectoparasite infestation and other health conditions deemed unacceptable by the veterinarian.

2. No greater than Grade 1 hip displasia either judged clinically or by X-rays.

3. Standard immunization series against disease completed.

4. Fully grown.

Temperamental and Behavioral Standards.

1. Evidence of inquisitiveness, with a desire to explore the environment. Especially, an apparent interest in odors, as evidenced by sniffing of new objects.

2. Neither aggressive nor shy of people.

3. Highly interested in food, an "eager eater."

4. Highly responsive and friendly to people.

Most reputable dog breeders will agree to sell a dog conditionally, and if possible, a dog should be purchased on the condition that it can be returned after a ten-day observation period if it does not meet all physical and temperamental standards. During the observation period, a qualified veterinarian should examine the dog to determine whether it meets required physical standards, and a Handler can observe whether the dog meets the necessary temperamental standards.

Simple observation tests can be used to determine whether a dog is temperamentally suitable for training. By taking the dog into a new environment, a Handler can observe whether the dog is inquisitive. For example, taken into a room in which there are boxes or containers such as foot and wall lockers, or furniture such as desks and tables, a naturally inquisitive dog will move about and examine these objects and, most importantly, it will sniff them. A dog which does not explore or sniff in new surroundings will probably be unsuitable for explosive detection training. Similarly, a dog's timidity and aggressiveness can be checked by taking the dog into a room where two or three strange individuals are present. If the dog proves shy of strangers or aggressive toward them, it is not a good candidate for detector dog training. A dog that is not very friendly to people it knows, and not responsive to petting and praise, should be rejected, since petting and praise will be employed as rewards in training the dog to search for explosives. Another important observation to make is whether the dog is a hearty eater. If it is, this is a good indication that food will be a powerful reward for it. If not, the dog should be rejected, since food will be one of the principal rewards used in training.

A dog in new surroundings may require an adjustment period and should not be judged too quickly. Normally the observation period of ten days will be needed to determine what a dog's behavior will be like over a more extended period.

In selecting dogs for training, twice as many should be selected as will actually be needed. In this way, the training quota can still be met even if some of the dogs are rejected in training. If more dogs than are needed successfully complete training, the best dogs can be selected to fill the quota.

## REWARDS AND PUNISHMENT

The presentation of rewards or punishment, whether with dogs or humans, serves to change the behavior of the animal. When a reward is presented just after the dog makes a particular response, the likelihood of that response occurring again is increased. The reverse is true of the administration of punishment. It is easy, then to see how certain behaviors can be modified so that they are more or less likely to occur simply by presenting rewards and punishment following certain behaviors.

When a dog first smells an explosive, it may sniff it and exhibit curiosity, but the odor has little additional effect on its behavior. However, if every time it smells an explosive odor it is put in a sitting position and given food, this sitting response is more likely to occur the next time that it detects this odor. The problem here is, of course, that the dog does not "understand" that sitting to an explosive odor is what results in the presentation of food and it will probably sit to many different objects. If the Handler does not present it with food when it sits to other nonexplosive odors, it will learn to discriminate between odors that are followed by food when it sits (certain explosives) and odors which are not followed by food (all other odors).

At the final stages of training, the dogs will search for the odor of the particular explosives that result in the delivery of food. The major thing to remember is that the dog will sit in the presence of an explosive odor only so long as it is given a reward for this behavior. It does not have to have a reward on every trial, but it does need to have frequent rewards when it responds to the correct odor.

If it goes for long periods of time without reward or if the reward is given at the wrong time, the dog's behavior will break down and it will either fail to search or fail to sit at the correct odor.

In the main, rewards such as food, praise, and petting will be used in training the dog in detection work. Details of how to most effectively employ these rewards will be discussed throughout this manual. But first, a short discussion of the use of punishment should clarify some of the reasons why excessive punishment is not the most effective way to train a detector dog, and may, in fact, be harmful to its training.

There are very few times when the use of extreme punishment will best serve to correct the dog for an undesirable behavior. A stern NO, during or immediately (not over three seconds) following the undesired behavior, will generally serve to reduce the chance of the behavior reoccurring. It should be emphasized that generally no physical punishment should be given during training sessions.

Punishment is effective in altering a dog's behavior only when administered following a behavior you do not want to occur, for example, if the dog bites someone.

Effective use of punishment can occur only after a good bond is established between handler and dog. Punishment tends to make the dog more handler-oriented and is especially ineffective for shy dogs.

If you want the dog to do something, reward it for doing what you want it to do, but never punish it for not doing it. Not only is punishment ineffective in getting the dog to do something, but it will cause the dog to fear the punisher and also it will fear the place in which it is punished. The effect of fear is to disrupt other behavior which, in many cases, may be desirable behavior. A fearful dog that receives punishment while searching will not make a good detector dog.

Spoken commands, such as GOOD DOG and NO, have no meaning to the dog except in relation to the events which follow these commands. If pleasant consequences follow the word GOOD, then eventually the word GOOD becomes rewarding to the dog. With proper training the word GOOD will continue to be rewarding to the dog even if it is only occasionally followed by food and petting. The same is true for NO when used as punishment. Granted a very loud NO may itself be punishing because of its startling effect; its effectiveness as a punishment results primarily from the unpleasant events which follow the verbal command NO. Thus, if a behavior occurs and is immediately followed by the word NO, that particular behavior will be less likely to reoccur. If the verbal NO is never followed by some unpleasant event, it will gradually lose its effectiveness in controlling the animal's behavior.

Many traditional dog trainers make extensive use of the choke collar as the primary tool in the training of dogs for various tasks. Although this practice is not recommended for the training of detector dogs, its effectiveness is recognized. The careful and limited use of the choke collar may be effective with some dogs which do not respond to the less severe punishments recommended in this manual.

Specifically, it is recommended that the jerk on the choke collar be used only under the following conditions: (1) If the dog bites another animal or a human; (2) If the dog runs away from the handler; (3) If the dog growls at a person or another dog. If any of these behaviors requiring the use of the choke collar occur, it is further recommended that a professional dog trainer who is thoroughly familiar with the use of the choke collar conduct this training.

For any other unwanted behaviors, such as sitting when no explosive odor is present, the NO should be paired only with a TIME OUT, a procedure which is described later in this manual. This procedure assures that NO will continue to function as an effective means of eliminating unwanted

behaviors. It is strongly recommended that NO and the TIME OUT procedure be the only punishment used during the training of detector dogs, except for the behaviors of growling at or biting people or other dogs, or running away.

Reward. The most effective way to control the dog's behavior is by rewarding it for desirable behaviors. You may reward it with food and with praise and petting. All these rewards are used during training.

a. Food. When the dog detects a designated odor and sits, it knows it is going to receive food. If the dog sits to some other odor, it knows it is not going to receive food. Therefore, it should receive its reward only when it makes a correct response, i.e., when it sits to the odor that it is being trained to detect. Do not give the dog food during the search training except when it makes a correct response.

b. Praise. Praise should accompany food as a reward. The verbal GOOD DOG is given prior to giving food to the dog when it has made a correct response. You will verbally encourage the dog to search and praise it when it is doing a good job of searching. Praise will become more and more effective as a reward for the dog the longer you work with it. Always use the same words: GOOD DOG always spoken the same drawn-out way, "Gooood Daaawg."

c. Petting. Praise should be coupled with petting when the dog makes a detection. Petting the dog as it is praised is very rewarding to it and will keep it working much in the same way as food does.

## MAXIMIZING THE EFFECTIVENESS OF FOOD AS A REWARD

The present dog training procedures differ from the traditional ones in that they do not rely on punishment for failure to respond, nor upon the dog's "affection" for the handler (the "one man, one dog" relationship). Petting and praise, although administered for correct responding, are regarded as auxiliary rewards only, since their effectiveness will vary from dog to dog and from handler to handler. The principal reward for correct responding is a pellet of food.

The procedure to be described will insure that any handler will be able to use food as a powerful reward for any dog that has met the selection criteria. Moreover, the effectiveness of food will be maintained even when the dog is shifted to a completely strange handler. Any properly trained handler will be able to work any properly trained dog.

While some dogs are highly rewarded by almost any kind of food, most prefer foods that would be impractical to use for routine training purposes. To be suitable for use in training, the food should be in the form of dry pellets. These are convenient to carry and to administer, and require no refrigeration. To make dry food pellets rewarding to any dog, it is only necessary to have the dog hungry. Depriving the dog of food for a period before working it is not sufficient, at least with all dogs; many dogs need also to have been on a restricted diet long enough to have lost a considerable amount of weight. The following procedure, while not essential for every dog, is sufficient to make virtually any dog responsive to dry food pellets:

(1) Start by giving the dog access to an unlimited quantity of a standard dry dog food, such as Purina Dog Chow, once a day. Record the amount eaten each day.

(2) Weigh the dog at the same time daily, preferably at a time prior to the feeding and make a chart of the weights.

(3) When the weight has been stable for approximately one week -- neither increasing nor decreasing -- take the mean for that week as the dog's free-feeding weight. On the dog's weight chart, draw a horizontal line at the free-feeding weight, and another at 80 percent of this weight.

(4) Continue feeding once daily, but limit the amount fed to about one-half the average amount eaten previously. Supplement the diet with a vitamin-mineral compound, such as Pet Tab. Weigh the dog daily at the same hour as before, and record the weights on the weight chart. Also record on the weight chart the amount of food being given each day.

(5) Allow at least one month for the weight to reach the terminal (80 percent) level; longer, if convenient When the body weight drops to the 90 percent level, increase the quantity of food by about 20 percent of the previous amount, and another 20 percent when the 85 percent body weight level is reached.

(6) After the desired 80 percent body weight level has been reached, begin a procedure of making small adjustments in the total food allowance in order to maintain the 80 percent level.

(7) The training program uses Prime pellets as rewards. Determine the quantity of the maintenance food that is equivalent to one Prime pellet, on the basis of the amounts of the two foods that the food packages specify for dogs of the same weight. Record the quantity of Prime given as reinforcement on each day and subtract its equivalent from that day's allowance of the maintenance food.

The general health, resistance to disease, and stamina do not seem to be affected by the weight reduction, but exceptional care should be taken in the prevention and prompt treatment of worms. Since worms can consume a considerable portion of the food eaten and the dog will have little food stored in his body, a severe infestation of worms could produce rapid inanition. Frequent routine worming and testing for worms is, therefore, even more important than for dogs on unrestricted diets.

For many dogs this severe weight reduction may not be essential for excellent performance. To determine whether a given dog will work as well at an increased weight, bring the weight up gradually, no more than 5 percent per week, by increasing the maintenance diet. Monitor the dog's performance carefully, especially on the more difficult tasks. If a reduction in efficiency or eagerness of search appears, the food allowance should be dropped back to its previous level for several days.

Increasing the dog's weight is hazardous if the dog will later be worked mainly by new handlers. As food becomes less rewarding, petting and praise may maintain good searching and detection as long as the old handlers work the dog, but petting and praise from the new handlers may not be effective and the dog's performance may deteriorate.

Errata Sheet (To be inserted after Page 8)

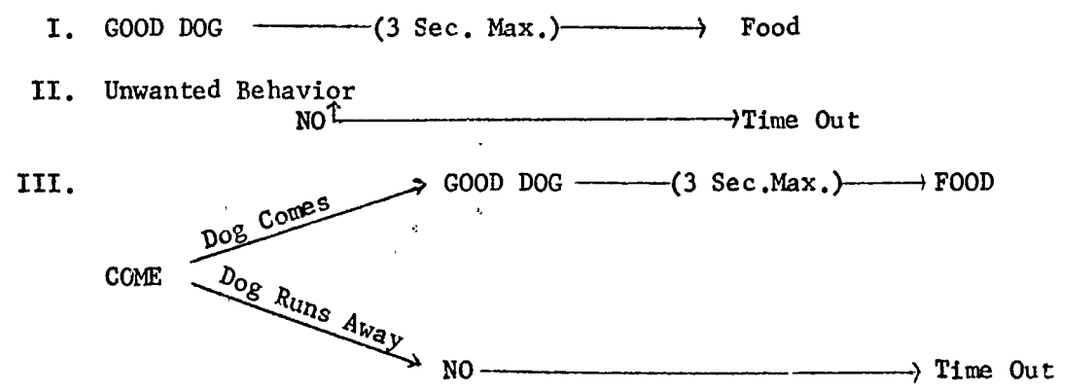
## PRELIMINARY TRAINING

Once the dog has been selected as a candidate for explosive detection training, the trainer should become acquainted with the dog. Preliminary training should begin during the "get acquainted" sessions. In the initial training phase, the dog will learn to come to the handler on command. In addition to being taught this behavior, the dog will also be taught the meaning of GOOD DOG and NO. These two commands will become meaningful to the dog through the pairing of these commands with rewards and punishment. Food will be used as the primary reward, and isolation (TIME OUT) will be used as the primary punishment.

Initially, the dog should not be required to make any specific response to receive the food reward. All the trainer must do here is to be certain that there is a close temporal relationship between the time the trainer says GOOD DOG and presents the food reward. It is essential that the presentation of the food reward come after the verbal GOOD DOG. However, the time which elapses between GOOD DOG and the presentation of food should not exceed three seconds. If the dog engages in some undesirable behavior during this initial training phase, the trainer should say NO and immediately isolate the dog (TIME OUT). It is essential that the verbal command NO be given at the time the unwanted behavior is occurring. This training should continue until the trainer feels the dog is beginning to learn that GOOD DOG means it is about to receive food and NO means it has done something wrong and will be isolated.

In the second phase of this initial training period, the dog will be rewarded for correctly responding to the verbal command COME. The dog will also receive a TIME OUT if its response to the verbal command COME is some behavior other than coming to the trainer. The most likely unwanted behavior will be the dog running away.

The following is a simple diagram of the essential behavioral components presented in this initial training phase.




During all training exercises praise and petting should accompany food as a reward. No praise or petting should be given during the time the dog is being punished.

## INITIAL OLFACTORY TRAINING

### Making the Training Odor Rewarding.

Once the dog has learned the meaning of the verbal command COME, and the sounds GOOD DOG and NO have been established as secondary reinforcers, the dog is ready to begin the first phase of olfactory training. The goal in this first phase is to establish the training odor (hexachloroethane or "Hex") as a reward. This means that the dog will begin to salivate and perhaps wag its tail when the odor is presented; or to put it another way, the odor becomes a signal that food and praise are to follow. The result of this conditioning procedure is to make reception of the odor rewarding for the animal. During the first phase of training, the dog is not required to do anything to receive the reward. The association between the odor and food and praise will be established simply through repeatedly letting the dog smell the odor and then immediately giving food and praise.

The following is a step-by-step account of the procedure which has been demonstrated to be effective in making the odor into a reward. The materials used in this phase of training are: (1) Six identical screw-top four ounce glass jars, each with a 1/4 inch hole in the cap; (2) For each jar, a 1 inch diameter wooden dowel, 36 inches long, on which to mount the jar; and (3) Approximately one level teaspoon full of the training odor (Hex) for each S+ jar. The following discussion will use the symbol S+ to refer to the odor to be detected and S- will refer to the absence of that odor.

There are several problems in training a dog to detect odorous materials, one of which is "contamination," i.e., any misplacement of an S+ odor to a place or object that is not intended to be an S+. The various S+ odors must be kept isolated from each other, and no S+ odor should come into contact with any material to which the dog may subsequently be exposed. Extreme care is essential in controlling for contamination, since dogs are capable of detecting incredibly small intensities of many odors. The best rule to follow in controlling for contamination is: Always handle the S+ odor last, and assume that anything you touch after you have handled the S+ material is contaminated; that is, there is enough of the S+ odor on the handled object for the dog to detect.

A dog's keen ability to detect odors is an obvious advantage in detection training; however, problems such as contamination will arise if extreme care is not taken when working with the various odors to be detected. The problem of contamination is fairly easy to handle in this first phase of training; however, proper control becomes more difficult in later training.

Before olfactory training begins, secure a separate place to store each S+ material. This must be a place to which the dog will never be exposed. Any person who handles an S+ material should confine himself to the area designated for that particular S+ until he has thoroughly washed his hands. All materials which are put into the designated area are then considered contaminated and should be kept in the area, thoroughly cleaned, or destroyed.

During this initial training, one S+ odor (Hex) will be employed. Later, in working with several S+ odors, a separate place to store each of the S+ materials will be needed.

In preparing the S+ and S- stimuli, always handle the S- before the S+ stimuli, never in the reverse order. This is a basic rule and must be observed during all phases of training. Failure to follow this rule is the most frequent cause of contamination. During this initial training phase, it is relatively easy to secure a separate place to store each S+ material and thus help control the problem of contamination. The simplest way to go about preparing the S+ and S- stimuli to be used in Phase I is to attach six identical jars each to a dowel and then load two of the jars with Hex. The same individual should make up both the S+ and S- stimuli; otherwise, there will be different human odors associated with the S+ and S- stimuli.

After coming into contact with any S+ odor, always wash your hands and arms thoroughly before handling any objects with which the dog will subsequently come into contact. In addition, change clothes if possible.

The initial olfaction training procedure will consist of two phases. The first phase can, if necessary, be conducted by one person. The second phase can be much more efficiently run with two persons.

The mechanics of this procedure are straightforward. During Phase I the dog should be tethered and the S+ and S- stimuli brought one at a time to the dog from where all stimuli are kept, approximately 10 to 15 feet away from the dog. A single trial consists of placing either the S+ or S- stimulus under the dog's nose. As the dog breathes, it will receive the S+ or S- odor. On S+ trials the jar is placed under the dog's nose and the Handler then says GOOD DOG and feeds and pets the dog. On S- trials the jar is simply removed. There is no food or petting given on these S- trials.

Following presentation of S+ and reinforcement or S-, the Handler turns, moves to the place where the S+ and S- stimuli are kept and obtains the appropriate stimuli for the next trial. If an additional person is available, he can tell the Handler whether the trial is an S+ or an S- trial and can record each trial on the data sheet. Otherwise, the Handler can mark the data sheet and note the condition for the next trial.

The schedule of S+ and S- presentations during Phase I is one of a random alteration with progressively fewer S+ and relation to S- presentations. The schedule begins with a ratio of two S+ stimuli for each S- and progresses through a ratio of 10 S- stimuli for each S+.

There are four blocks of trials at each ratio. This schedule results in 44 reinforcements in 197 trials. Broken down, the number of reinforcements and number of trials at each ratio are as follows:

| Reinforcements | in | Trials | at | Ratio |
|---|---|---|---|---|
| 8 | | 12 | | 2-1 |
| 4 | | 8 | | 1-1 |
| 4 | | 12 | | 1-2 |
| 4 | | 20 | | 1-4 |
| 4 | | 24 | | 1-5 |
| 4 | | 28 | | 1-6 |
| 4 | | 32 | | 1-7 |
| 4 | | 36 | | 1-8 |
| 4 | | 40 | | 1-9 |
| Totals 44 | | 196 | | |

Appendix I consists of 3 sample data sheets, one of which (No. 1) has been filled in and can be used as the schedule to follow. The trials in Phase I can be given in one day or can be spread over two days. It is suggested that if half the trials are given on each of two separate days, on the first day the ratios 2-1 through 1-4 should be conducted and on the second day the ratio 1-4 should be repeated, followed by the progression 1-9.

The procedure in Phase II is almost identical to that of Phase I. The only difference is that instead of bringing the S+ or S- jar and dowel to the dog, as was the case in Phase I, the handler walks the dog to the dowel and jar assembly, which is held horizontally by a second person. The same schedule is followed in Phase II as was followed in Phase I.

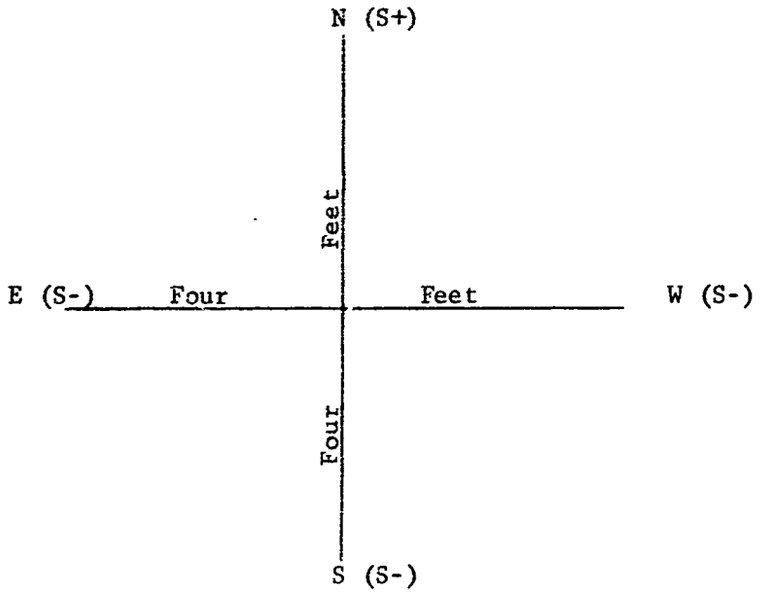
Data Sheets.

The data sheets should be made out before beginning the training session and should follow the general format of the sample data sheets. The schedule of reinforcements proceeds across the page from left to right, going from one ratio to the next. A plus (+) in column means that on that trial an S+ stimulus should be presented to the dog and the dog should be rewarded. A minus (-) in a column means that an S- stimulus should be presented and the dog should not be rewarded. As each trial is completed, it should be checked off in the box below the + or - designations. In this way, one can be sure that he completes the training according to the schedule. The complete schedule is shown

in the sample data sheets in Appendix I. A partially completed data sheet is shown in the first sample sheet. As can be seen, forty trials have been run. The dog has received 19 + trials on which it received food and praise and 21 - trials where there was no reward. The schedule given here can be used in both Phase I and Phase II.

## SIMPLE DISCRIMINATION TRAINING

Once Phases I and II of initial olfactory training have been completed four-choice discrimination training should begin. Discrimination training means training in which the dog will be required to make a distinction between the S+ and S- stimuli. During this phase the dog will learn to sniff the jars and to sit when it sniffs the S+ jar. To insure control of the dog's movements, this phase of training should be conducted with the dog on-leash. This training can be conducted inside a building or, if there are no strong wind currents, it can be conducted outside. The materials used in this training will be three S- jars and one S+ jar, identical to those used in initial olfactory training. These jars are placed in four positions: North, west, south, and east (see diagram below).




This diagram represents the physical plan used to conduct four-choice discrimination training. There are four jars: The S+ jar is in the north (N) position and there are S- jars in the west, south, and east positions.

There are approximately four feet between the jar in the N position and the jar in the S position, and a like distance between the jars in the E and W positions. The positions of the S+ and S- stimuli are changed on each trial. Thus, if the S+ is in the N position on one trial, it will be changed to another position on the subsequent trial. This training should be continued until the dog reliably sits after it sniffs the S+ jar and does not make a sit response to the S- jars.

Initial Discrimination Training.

In the initial discrimination training trials the dog will only be required to sniff the S+ jar to get the reward. Timing is very important here. At the instant the dog sniffs the S+ jar, the Handler immediately says GOOD DOG and gives the dog the food reward. The training should begin with only the S+ jar for a few trials. As soon as the dog has learned to sniff the S+ jar, one S- jar should be added. Then, after the dog has received several trials with the two stimuli, add the third and fourth jars.

After the dog has been run through several trials in the four-choice discrimination task, it will begin to alert after it sniffs the S+ jar. Once this alerting behavior is noticeable, the sit response to the S+ stimuli should be added.

When the dog sniffs the S+ jar, the Handler says GOOD DOG and, at the same time, pushes down on the dog's hips with his left hand and puts the food in the dog's mouth and pushes the dog's nose and mouth backward with the right hand, as shown in Figure 1.

As the dog is pressed into the sitting position, the command SIT should be continually repeated. After a few trials, the physical and verbal cues should gradually be reduced until the dog is sitting to the S+ without being prompted by the Handler in any way.

No two dogs will learn at the same rate; thus all training must be programmed to suit each individual dog. The entire training program is based on the gradual assimilation of new behaviors which can only be learned if the dog has mastered the previous task. If a dog is slow in learning a particular task, it is essential that it be given additional practice at this task before it is introduced to the next training task. If a dog is pushed into new learning situations, before it has mastered a more elementary one, it probably will not be able to learn the new task. Do not make the mistake of rushing the dog. Be certain it has mastered one task before moving to the next. Anytime the dog is performing poorly it is essential to revert to a simpler task; once it is performing well, gradually progress to the more complex task. If the dog continues to perform poorly on the simpler task, training should be temporarily discontinued.

Search Command.

It is desirable to have the dog search on command. Upon entering the area to be searched, the dog should be given the command SEARCH.

There will be times when the dog will be required to search some particular area or object within the general area being searched. In these instances the Handler should move to the area or object, get the dog's attention, indicate the object by moving his finger to the object, and give the search command.

NOT REPRODUCIBLE

Figure 1. Initiating the SIT response.

To insure the dog's prompt response to the search command, some rather careful training will have to be given. This training should begin as early as possible, preferably during the first stages of the four-choice discrimination task. The dog must learn that when an area or object is indicated and the search command is given, it is more likely to detect an S+ odor than if it ignores the command. In order to establish and maintain this "search-find-reward" association, systematic conditioning of this association throughout training is necessary.

Establishing the association between the verbal command SEARCH and the increased likelihood of finding an S+ during the initial trials of the four-choice discrimination task will facilitate more rapid learning of the discrimination task, and in addition, will establish the search command as a signal for the dog to search more vigorously.

In order for the dog to learn to search more vigorously when the search command is given, the Handler will have to give the dog the command just prior to making a detection. Begin by giving the command prior to the detection of the S+ on every trial. After several trials in which the search command is given on every trial, the command is then given on progressively fewer trials. The ratio schedule followed in initial olfactory training (see schedule, page 11) is a good schedule to follow in programming the trials on which the dog receives the search command.

In following this schedule the dog should be given the search command just prior to S+ detection on each trial where there is a + recorded. On trials where there is a - recorded, the dog receives no verbal command. As the schedule indicates, the search command is given on trials 1, 2, 4, 6, 8, 9, 11, 12, and so forth. Following this schedule results in fewer and fewer trials in which the search command is given.

If the search command were given just before the dog sniffs the S+ and at no other time, the dog would soon learn that any time it hears the search command and sits, it will be rewarded. To insure that this behavior does not develop, the search command should be given just before the dog sniffs the S- stimuli on some trials. The percentage of times it is given to S- should be increased gradually.

The systematic presentation of the command SEARCH outlined above will result in the dog learning to search more vigorously when the search command is given; but the dog will continue to rely on the sense of smell in making the distinction between S+ and S-.

Touch -- Do Not Disturb.

After the dog has learned that the S+ odor means reward, it may, if not corrected, develop a potentially bad habit. Occasionally a dog will paw the S+ jar or may even take it into its mouth. Needless to say such behavior would be undesirable when the dog is searching for explosives. Therefore, do not allow this habit of pawing, biting or otherwise disturbing to develop. Of course, it would be even better for the dog not to touch the S+ object at all. Practically speaking, however, such a prohibition would slow down the training and would also reduce the dog's detection capabilities. In order to keep this habit of pawing or mouthing the object from developing, do not reward the dog if it engages in these behaviors. This problem does not generally arise if reward follows the sit response very quickly. However, if there is a delay between the time the dog sits and the time when it is rewarded, such behavior may occur. If the dog displays the behavior and is subsequently rewarded, it is likely to respond in the same way on the next trial. Therefore, if the dog paws or otherwise disturbs the S+ stimuli, it is relatively easy to keep such a habit as this from developing; but once it has developed, it may be extremely difficult to break. So do not allow these behaviors to develop. If the dog engages in these behaviors before it sits, the verbal command NO is given followed by the command SIT. If the dog responds to these commands, that is, if it stops disturbing the S+ and sits, it should be given a food reward. If it does not stop engaging in these behaviors when the command NO is given, the NO command should be repeated and the dog removed from the area.

The rule is: The dog may touch the object but it is not to disturb it.

False Sits.

There will be occasions when the dog will sit where there is no S+ present. In the four-choice situations there are three S- jars and one S+ jars. This is an error which is referred to in this manual as a "false sit."

The question is: What to do if the dog sits to one of the S- stimuli? While there are various possible ways to deal with this type of error, the best overall is to give the conditioned negative reinforcer NO followed by removing the dog from the vicinity of the S+ and S- stimuli. For example, if, during discrimination training in the two, three, or four-choice discrimination task, the dog approaches, sniffs the S- and sits, the Handler should say NO in a normal tone and take the dog back to the starting position. Do not pet or otherwise praise the dog until it has made a correct response. In most cases this correction procedure will suffice to eliminate false sits. If the dog continues to make false sits in this situation, it is most likely that it has not made the association between the odor and the sit response.

If the association between the S+ odor and the sit response apparently has not been made, revert back to giving praise and food without requiring the dog to sit. That is, when the dog starts to make systematic or frequent errors, return to a more elementary stage of training and work back up to the point where the desired behavior started to break down. Do not wait until the undesired behavior has become chronic before backing up. Always back up enough to insure that the dog will respond successfully; then, after a period of correct responding at the more elementary level, continue to move gradually toward the desired goal.

## SIX-CHOICE DISCRIMINATION TRAINING

Once a dog has learned the four-choice discrimination task (100 percent correct responses for at least one entire session), the next step in training is the standard six-choice discrimination task.

The apparatus is shown in Figure 2. It should be set up in an inclosed area where there are no noticeable wind currents. Two trainers are necessary to conduct six-choice discrimination sessions, a Programmer and a Handler. The Programmer will change the S+ and S- stimuli and keep the data. The Handler will handle the dog and administer rewards for correct responses.

There are six phases of training which should be completed with the training odor (Hex) in the six-choice discrimination task before any attempt is made to work with explosive odors. The six phases are as follows:

1. Acclimation.

2. S- odors added to empty jars.

3. Delay in reward training.

   a. Primary (food).
   b. Secondary (praise).
   c. Primary and secondary (food and praise).

4. Handler's knowledge of the position of the S+ eliminated.

5. Off-leash training.

6. Sensitivity training.

These steps should be taken one at a time and performance should approximate 100 percent correct responding at each step before the next step is taken.

Step 1. Acclimation. Acclimation bridges the gap from simple, four-choice discrimination to the new apparatus and procedure. Two adjoining rooms should be used. One room will house the apparatus and the second room is where the dog is kept between trials. The dog is run on-leash in the first four steps of training and off-leash during the last two steps.

The Handler will bring the dog into the room and give the search command. He will then lead the dog to the six jars. Before the dog examines the jars, the Programmer will tell the Handler which position

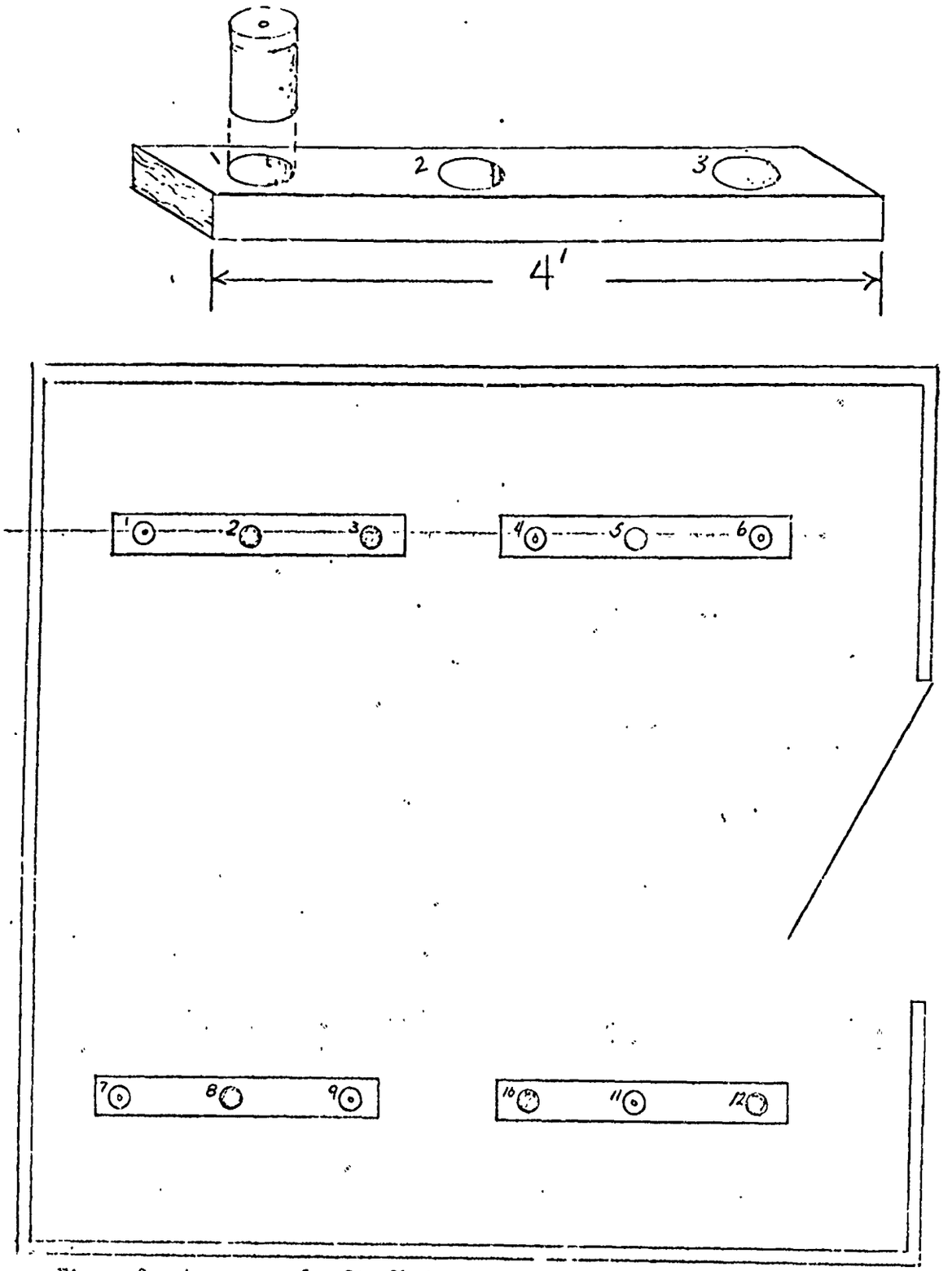



Figure 2. Apparatus for Six-Choice Discrimination Training. The inclosed area represents a room in which there are four four-foot 2 x 4's. Three holes, large enough that the four-ounce jars fit into them easily, are bored about 22 inches apart in each board, and are numbered 1 through 12. In the diagram there are jars in holes No. 2, 3, 5, 8, 10, and 12. There is always one S+ jar and five S- jars present on each trial.

the S+ occupies on each trial. This is done so that reward or correction can be given immediately after the responses.

Correct Response. If the dog comes into the room, sniffs the jars, does not sit to the S- jars, and sits to the S+ jar, it should receive food, petting and praise and then should be taken from the room to await the next trial.

Incorrect Responses. If the dog sits to one of the S- stimuli, this is an incorrect response and terminates the trial. If the dog sniffs one of the S- stimuli and starts to sit, the Handler should say NO and immediately remove the dog from the room. There should be no food or praise given until the dog makes a correct response on a subsequent trial. The above kind of error is a false sit.

Another type error is a failure to sit when the S+ stimuli has been sampled. There is no correction for this error. The dog is simply redirected to all stimuli.

If either of these errors persist, revert to an easier task. In this case, if the dog continues to make errors, revert to the procedure used to establish the sit response to the S+ jar in the four-choice situation, except continue to use the six-choice discrimination apparatus.

The Programmer will move the S+ and S- stimuli to new positions on each trial. He will tell the Handler the new position of the S+ on each trial and keep the data sheets. A sample data sheet for recording the data in the six-choice discrimination is presented in the following section.

In addition to the dog's becoming familiar with the new apparatus, this initial training step will allow both the Handler and Programmer to become familiar with the procedure and the data collecting.

Step 2. Introduction of S- Odors. Once the dog can discriminate the S+ from the five empty jars, other odorous materials should be put into the empty jars. The purpose here is to insure that the dog is not simply responding to "something versus nothing" but that it is discriminating the odor of the S+ from other odors. Any foreign odor can be used as an S- odor, and the more different S- odors introduced into training the better. Any material which has been or will be systematically associated with the S+ stimuli must be included. For example, any packaging material used with the S+ odor should be included as S- material. The operational procedure is the same as in Step 1. A record should be kept of any S- odors to which false sits are made.

Step 3. Delay of Reward Training. Up to this point the person who handled the dog has known the position of the S+ prior to the dog's response. Knowledge of which jar contained the S+ odor insured that the

reinforcement, as later in training there will necessarily be times when immediate reinforcement is not feasible; unless the dog has had some exposure to such delays in reinforcement, an unexpected delay could disrupt the dog's behavior.

There are three phases in this training step. Phase A introduces a delay between the time the Handler says GOOD DOG and the time he gives food. Phase B introduces a delay between the time when the dog sits and the time the Handler says GOOD DOG. Phase C is a combination of both these delays on a single trial. Although the length of delay in reinforcement may be extended later in training, a moderate delay (up to 5 seconds) should be sufficient at this stage of training. Each delay should be built up gradually beginning with no delay.

Step 4. Elimination of the Handler's Knowledge of Position of S+. Under most training conditions the Handler should not know the position of the S+ stimuli. The reason for this is that a Handler who knows where the S+ is cannot avoid giving cues to the dog, even though he may be unaware of doing this. It can be assumed that if he does not know where the S+ is located, he cannot cue the dog to the S+. Therefore, during this training step the Handler will no longer know the position of the S+ until after the dog has made a response. The dog is brought into the room and is guided to the jars in the same manner as in prior steps. When the dog responds, the Programmer will quietly say YES to the Handler if the dog has responded correctly and NO if the dog has responded incorrectly. The Handler will then reward for correct responses in the usual manner.

Step 5. Off-Leash Training. The dog should be trained to work on-leash and off-leash. Once the dog is working well on-leash with a Handler who does not know the position of the S+ samples in the six-choice discrimination task, a series of trials with the dog off-leash should be run. If the dog has been working well on-leash there should be no difficulty in working it off-leash. The dog's search pattern can be directed by pointing to a particular object and by verbally encouraging it to search. The Handler should not know the position of the S+ until after the dog has responded during off-leash training.

Step 6. Sensitivity Training. Hex is an intense odor and can very easily be detected. In order for the dog to detect the weaker explosive odors, it will need to sniff in the most effective way and to attend to very faint odors. This is the reason why, before working with the explosive odors, the dog should be trained to respond to low concentrations of the training odor in the six-choice discrimination task. When the dog has mastered the discrimination task with a 3/8 inch hole in the top of the S+ jar, the hole should be made smaller and smaller. The recommended sequence is 1/4, 3/16, 1/8, 3/32, 1/16 inches and a No. 60 drill size. Once the dog has learned to detect even the faintest amount of an S+, there is less chance that difficulties will arise in training it to search for the S+.

## PERFORMANCE RECORDS FOR DISCRIMINATION TRAINING

It is essential to keep records of the dog's daily performance during discrimination training, for use in planning the next day's training session. If several dogs are being trained, it is difficult to recall the details of each dog's performance. Every dog will have individual strong and weak points at anytime, and these must be considered in planning its work schedule.

Graphical presentation of the records for example, graphing the daily percentage of detections throughout training is not necessary. Such graphs contain very little meaningful information, for this reason: The recorded level of performance depends largely upon the intensity of the odors that are being used, but the selection of the odor intensities to use at any time depends upon the trainer's judgments as to the dog's current performance. The principal use of the daily records is thus to aid in planning the next day's training, not to evaluate the progress of the dog. They also indicate any tendency of the Programmer to place the S+ in certain locations too frequently, or to favor certain changes in location from one trial to the next. If desired, the locations can be listed in advance, to assure that the locations are at least semi-random.

A sample data sheet used in six-choice discrimination training is shown in Appendix II. The symbols used in keeping these data sheets are: S+, S-, +, -, and 0. The number in the location column represents the location of the S+ stimulus in the room. Response to the S+ odor is recorded in the column labeled S+. A plus (+) in this column means that the dog sniffed the S+ odor and sat down beside it. A minus (-) in the S+ column means that the dog sniffed the S+ odor and did not sit but moved on. A zero (0) in the S+ column means that the dog did not approach the S+ odor at all. The five columns labeled S- are the spaces to record responses to S-. The correct response, i.e., sniffing the S- odor jar and moving on, would be recorded by placing a minus in the S- column. The location of S- odor jars need not be recorded unless the dog sits to an S- jar. When this occurs, the trial terminates and a plus is recorded in the S- column along with the position number of the hole where the S- jar is located. An asterisk (*) in the S- column is used to indicate that the dog was cued by the Handler for some reason. An explanation such as the one on the sample data sheet (trial 5) should be indicated.

Trial 7 shows a plus in the S+ column and two minuses under the S- group. This indicates that the dog attended two S- jars before going to the S+ odor. The correct response to an S+ odor terminated Trial 7 at that point. The record for Trial 1 on the data sheet shows that the dog

sniffed the S+ odor and moved on without sitting. It then sniffed an S- jar and sat down. An incorrect response to an S- ends the trial. The data recorded for Trial 2 shows that the dog did not approach the S+ odor (0 in the S+ column). The dog did attend two S- jars and sat to the second S- jar, thus ending the trial. In Trials 3 and 4 the dog attended all five of the S- jars and then came to the S+ jar to which it responded correctly.

## DISCRIMINATION TRAINING WITH EXPLOSIVES

Transition from Easy to Difficult Explosive Odors.

After the dog has progessed through the six training stages just described, it is ready to begin discrimination training to various explosive odors. Prior to the beginning of training to any explosive odors, it is best to determine all of the kinds of explosives the dog will be expected by the user to detect. Explosive compounds vary tremendously in the amount of odor they produce. That is, some explosives, such as dynamite and C-3, have intense odors, whereas others, such as TNT and RDX, give off very little odor and are, in fact, considered odorless to humans. Although the correlation between human and canine olfactory sensitivity to various substances has not been investigated, it may be assumed that, in general, what has a strong odor to humans also has a strong odor to dogs; and a material which has a weak odor or nonexistent odor to humans is unlikely to have a strong odor for dogs.

For the purpose of this manual the following explosives will be considered:

1. Commercial ammonium nitrate dynamite.

2. Commercial straight nitroglycerin dynamite.

3. C-3.

4. C-4.

5. Smokeless powder.

6. Black powder.

7. RDX.

8. TNT.

The first four explosives included in this list (two types of dynamite, C-3, and C-4) all are odorous to humans, and are easily detected by dogs. Smokeless powders of various compositions all contain nitrocellulose; double base powders also contain nitroglycerin and both single and double base smokeless powders contain various non-volatile solvents. As a result, smokeless powders may vary greatly in odor intensity. Explosives Nos. 6, 7, and 8 (black powder, RDX and TNT) are generally odorless to humans and are relatively difficult for dogs to detect.

In training a dog to detect any combination of these explosives, the training should be given in the same sequence as the explosives are listed. That is, train the dog first to detect both types of dynamite, then C-3, C-4 and so on down the list. It is not necessary to train the dog to detect all the explosives in the list, nor to confine the training to the explosives listed here. Regardless of which explosives are used, the training should be given with the less odorous explosives last.

Training Procedure with the First Explosive.

After completing the six steps outlined above, the dog should be ready for training to the first explosive odor (commercial ammonium nitrate dynamite). The procedure presented here for training the dog to respond to an additional S+ is relatively simple and has been found to be very fast and effective. The same six-choice discrimination procedure previously used with Hex will be used to train the dog to new odors. The technique for transferring to the new S+ odor, which in this case is dynamite, is as follows:

1. Begin the session with a few trials using the training odor; this will assure that the dog will work well on the six-choice discrimination task.

2. Once the dog is working well, remove the jar containing the training odor and put the new S+ jar, which contains a generous quantity of dynamite, in its place.

3. On the first trial with the new S+, the dog is brought in and will begin to sniff each of the jars, just as it has previously done. At the precise instant the dog sniffs the new S+ jar the Handler should immediately say GOOD DOG and feed the dog. Initially the Programmer will tell the Handler the position of the S+ (dynamite) prior to the beginning of the trial. As the dog is fed it is gently placed in the sitting position in the same manner as in early training Continue in this manner until the dog starts to alert when it sniffs the S+. At this time gradually demand more and more from the dog. Give it time to sit without being coaxed or physically assisted. Once the dog begins to sit on its own, delay saying GOOD DOG for a second or two, thus giving the dog a chance to sit before reinforcement is given.

The rate at which the dog learns to respond to the new S+ odor depends largely on how well the Handler times his responses. If his timing is poor, the dog will take a much longer time to learn to respond to the new odor. The most essential aspect of this transfer procedure is that the verbal cue (GOOD DOG) comes at the exact time the dog sniffs the new S+ jar. If the timing is good, it will take only a few trials for the dog to begin to associate the new odor with food and praise. Once the dog has learned this association, progress through all the steps in Six-Choice Discrimination Training with the new odor. This should not take as long as it did with the training odor.

As with all other procedures in this manual, any time the behavior of the dog becomes disrupted, go back to a task the dog has previously learned. Reinstate the desired behavior and then gradually move to the new task. If during the initial trials with the new S+ the dog begins to make errors or quits sniffing the jars, go back to using the training odor until reliable responding is reestablished; then reinstate the new S+ on some of the trials.

## BASIC ROOM SEARCH

To have much practical value, the dog must not only learn to discriminate S+ odors, it must also learn to search an area actively and to locate an explosive material if one is present. After the dog has learned to discriminate Hex and dynamite in the six-choice situation, room-search training should begin.

During room-search training the Handler should never know the location of any S+ samples. Consequently, it will always take at least two people to run room-search trials. If the Handler knows where the S+ has been planted, he will almost certainly cue the dog, even though he is deliberately trying not to do this. Therefore, it is essential that the Handler not know the position of the S+ during room-search training. There will be times when the dog should be directed during room-search training. The Handler can direct the dog to search a certain specific area or a particular object if he thinks the area may contain likely hiding places, but he runs a great risk of unconsciously cuing the dog if the location of the S+ stimuli is actually known. After the dog sits, the Programmer will give the signal YES (correct) or NO (incorrect) and the Handler will reinforce the dog accordingly.

Begin room search in a relatively small room which is uncluttered. On the first trial an S+ jar and two S- jars should be placed in very obvious places where the dog will be able to see them. These initial trials may be run with the dog on- or off-leash. The reinforcement contingencies are the same in room-search training as in the six-choice situation -- immediate reinforcement when the dog sits. That is, give food and praise if the dog is correct or NO and removal from the room if it is incorrect. The Programmer will know which jar contains the S+ on these trials and will signal the Handler immediately following the dog's response. The location of the S+ and S- samples should be moved by the Programmer on each trial. Once the dog is responding reliably to the easily located S+ jars, the task should be made more difficult by planting the S+ jars in less obvious places in the room. This should be done gradually so the dog will have to work just a little harder on each trial. After the dog has learned that it has to move around the room and sample several S- jars in order to locate the S+ jar, then partly hide the S+ and S- jars, i.e., have only a small part of each jar visible. For example, the jars may be placed in open boxes which are scattered around the room.

Continue to reduce the visual cue until the jar is completely out of sight. The dog must then rely completely on the sense of smell to locate the S+ odor. Once this is done, the proportion of the jars that are S- can be reduced to approximately one-fourth.

In an earlier section it was pointed out that the dog may touch but may not disturb S+ samples. There is a possibility that as the visual cue is faded out the dog will try to find the S+ jar by nosing the place where it is hidden or by pawing the object that conceals the jar. Here again the rule is not to let these habits develop. If the dog sits and then begins to display such behaviors, the Handler should say NO. If the behavior occurs before the dog sits, the Handler should say NO and give the sit command.

After the dog has learned to sample a limited area with the S+ hidden from sight, training should move to a larger area which contains more objects. As with all phases of training, always program in small steps and be sure the dog has learned one task well before taking the next step. If the progression to a more difficult task indicates that the dog is not performing well, do not continue to run the dog in this situation. Go back to a task in which the dog has done well and then gradually move toward the more difficult task.

Once the dog is responding well in one room with several objects, additional rooms should be incorporated into the dog's search pattern. During the initial room-search training, there should always be at least one S+ in every room. The number of rooms to be searched should be increased gradually. Once the dog is performing well in the multi-room situation, there should be introduced some S- rooms, that is, rooms in which there has been no S+ planted. The Handler should not be told in advance whether a room he is about to search is an S+ room or an S- room.

It is not essential that the dog detect every S+ which has been planted. However, as fewer rooms come to have an S+ planted in them, and as larger rooms are used, care must be taken not to require the dog to search too many and too large rooms without detecting an S+. If area searched per detection increases too rapidly, the search behavior may deteriorate. So, progress slowly in increasing room size or decreasing the number of S+ rooms; the dog should adapt only gradually to searching larger and larger areas in which there are fewer and fewer S+ stimuli present.

Recording of Performance.

The data sheet in Appendix III represents a record of the performance which might be expected from a dog with limited multi-room search training in the detection of Hex, dynamite, and C-4. The analysis of the data sheet is also presented to illustrate some of the conditions which will likely be experienced during this stage of training. In addition, the analysis should further illustrate an efficient method of keeping a record of the dog's performance.

The data sheet for room search should have spaces to record the trial number, room number, whether the room contains an S+, the type of S+, if any, and should have columns for recording the dog's performance. The sheet should be labeled with information regarding the purpose of the training session, the place, the date, the name of the dog, and the names of the Handler and Programmer.

The dog's performance in each room and the time spent in each room should be recorded for each trial. A plus (+) recorded in the column headed condition (cond.) indicates that the room contains an S+. A minus (-) in the condition column indicates that there is not an S+ in the room. If the room contains an S+, an initial identifying the type S+ should be put beside the + in the condition column. Thus, +H for Trial 1 indicates that Hex is planted in that room. If the dog detects the Hex and sits, a plus should be recorded in the Hex column. In Trial 3 the S+ is dynamite; therefore, a +D is recorded. The data for Trial 4 indicates that dynamite was planted in Room 6 but the dog did not detect it. The minus in the dynamite (Dyn.) column for Trial 4 shows that the dog approached the dynamite but did not sit. On Trial 5 the dog sat in an S- room. This is recorded by placing a plus in the column headed S-. Trial 6 shows that C-4 was planted in Room 5 and was detected.

As can be seen from the times recorded for the other rooms, the dog was kept in Room 5 for a longer period than in any of the other rooms. Although a dog should examine a room carefully, it should not be retained in a room for longer than necessary to complete the room search. If there is an S+ in the room, the dog will likely detect it in a relatively short period of time. As Trial 5 illustrates, if the dog has searched a room and is retained there and made to search the same area repeatedly, the possibility of false sitting is increased. As different dogs are trained, the trainer becomes aware of their individual capabilities and will learn the speed at which a particular area can be searched most effectively.

There are two components to good search strategy: (1) Percent detection, and (2) Speed at which the dog searches an area. Ultimately the dog must search an area as quickly as possible and make a high percentage of detections. If the dog does not sit in an S- room, the Programmer need only record the time spent in the room. Trial numbers are marked to show the order in which the rooms are to be searched. The Programmer plants the S+ materials, prepares the data sheet, directs the Handler to the rooms according to the order outlined on the data sheet and records the dog's performance.

Note that the schedule gets progressively leaner (fewer S+ rooms) as the session continues.

If at any time during the session the dog is cued, i.e., led to the odor, this should be recorded as such by placing an asterisk and explanatory comment for the trial. The data for Trial 7 show that the dog responded incorrectly but was prompted to do so by the Handler. The recording of Trial 11 differs from that of Trial 7, but it is still an example of cueing. On Trial 11 the dog spent 40 seconds in the room without detecting the S+. At that time the Handler was told the general location of the S+ and was instructed to direct the dog to that area. The asterisk and explanatory notes were again used to indicate that the dog was cued.

After the entire training session has been completed, a brief summary of the dog's performance should be recorded. Any special problems or unusual behaviors should be included. A brief statement of what would be desirable in the next training session should be made.

Transition from Discrimination Task to Room Search with the First Explosive.

There should be very little difficulty in progressing from the six-choice discrimination task to room search with the explosive odor. The dog has already learned to do room search for one type of S+ (Hex), and the search pattern is the same regardless of which S+ is in the area.

The dog should display nearly perfect performance on the six-choice discrimination task before the new S+ is included in the room search sessions.

When the explosive is first included in room search sessions, Hex samples should also be hidden in each room, and the number of explosive samples initially hidden in each room should be double that of the Hex samples. On subsequent sessions the number of the Hex plants should be decreased gradually. The rate at which the Hex plants can be decreased will depend on how quickly the dog learns to respond to the explosive plants.

If the dog fails to detect most of the explosive samples on these initial sessions, they should be made easier to detect; once the dog begins to detect most of them, they can be gradually made more difficult to detect.

The first few times the dog detects the explosive odor in the search situation, it may not sit. Should this happen, give the SIT command if it is obvious that the dog has detected the odor. It will probably then sit to the new S+ in only a few trials.

## ADDITIONAL EXPLOSIVE ODORS

The same methods that were described for training the dog to discriminate and search for dynamite should be used in training the dog to respond to each subsequent explosive. It should be emphasized that the dog must be well-trained to all previous S+ odors before an attempt is made to add an additional odor. That is, the dog should have nearly perfect performance in the six-choice discrimination task and should be performing well in room search with every previously conditioned S+ odor before another S+ odor is added. The reason is that each additional odor increases the difficulty of the detection task.

## ADVANCED ROOM SEARCH

Advanced room search is the most lengthy phase of the training program, and is also the last phase of training before the dog can be considered ready for operational use. It differs from basic room search only in the degree of difficulty of the task for the dog. As advanced room search progresses, the dog is given practice in searching for S+ samples that are under greater and greater degrees of concealment. An increasing diversity of situations, hiding places, masking odors, packaging, etc., is used so that by the end of this phase the dog should have been trained to find the explosive samples under conditions approximating almost any it is likely to encounter in actual bomb detection.

Advanced room search is not a discrete phase of training, but rather is a gradual development from basic room search. Once the dog is able to find "easy" samples of a particular S+ in "easy" locations, the samples are gradually made more difficult to find, in a variety of ways such as the following:

1. Quantity of S+ material in the jar may be reduced. With the more odorous materials, such as dynamite, the amount may eventually be reduced to a few hundredths of an ounce.

2. The S+ materials may be diluted with larger and larger quantities of S- materials of as many varieties as convenient. S- jars, containing the same diluents and prepared by the same individuals as the S+ jars, must also be used.

3. The S+ packets, instead of being housed in glass jars, may be wrapped in paper or plastic, may be boxed in pasteboard boxes, or both. The wrapper or box may then be sealed to various degrees with plastic tape. Similar packages, containing packets of various S- materials, should be used along with the S+ packages. If this is done, the same individual(s) who make up the S+ packages should also make the S- packages; the S- ones should always be made first, in order to avoid contaminating them with S-- odors. The number of different individuals who prepare the S+ and S- packages, and also the number of different kinds of packaging and sealing materials, should be as large as practicable.

4. The time the odor sample has been in place before the room is searched can be lengthened and also made more variable. Times up to 24 hours should be included. As with the other changes mentioned, this change must be introduced gradually. The sharp odor gradient which has characterized the recently planted samples may often dissipate over time, making it difficult for the dog to localize the source of an odor.

5. Rooms containing gradually stronger and more varied masking odors should be included. The odors of paint, petroleum products, clothing, people, food, animals, chemicals, and vegetation are all good

## USE OF THE TRAINED DOG IN BOMB SEARCH

### Types of Sessions.

The specific way in which bomb search is conducted will influence the exact manner in which the detector dog will be used, since the detector dog team must fit into the overall bomb search plan. Hence, while the following procedures have been found to work well in bomb searches where they were used, they may have to be modified somewhat to meet particular user requirements.

There are three types of sessions, but the procedures for all three types have much in common. The three types are as follows:

a. Operational session. This session is under conditions of actual bomb threat. During the operational session the team will keep records of the dog's performance and of any special problems which may arise.

b. Maintenance session. This is a training and evaluation session. Any special problems in the dog's detection performance can be systematically evaluated during these sessions, and any corrective procedures which seem needed can be carried out.

c. Evaluation session. This is as similar as possible to the operational session except that an actual bomb is hidden, to test the dog under simulated operational conditions. The bomb must be planted by a person who is not directly associated with the detector team itself.

### Programming S+ Samples.

The number of S+ samples planted in the area to be searched in a session constitutes the "program." If the dog is scheduled to search 10 rooms, then the number of S+ samples placed in these 10 rooms would be the "program" for this session. This could range from one or more S+ samples in each room to one S+ sample in only one of the ten rooms.

The programming of the S+ odor is perhaps the most difficult task the detector team will face. The question is: How many S+ samples do you place during any particular session? Unfortunately, no very precise guidance can be given, and the decision will have to be made largely on the basis of guesswork by the Programmer. The number and type of S+ odors to be planted will necessarily depend on many different conditions and the best program will not be the same for all dogs. The environment in which the dog is working will require different schedules of S+ programming. The day-to-day changes in performance of the dog will also affect subsequent programming.

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The basic rule for determining the number of S+ samples is: Plant the number of S+ samples estimated to be required to keep the dog actively searching, plus a very few additional ones "for good measure." If the program is too lean (too few S+ samples) the dog will not maintain good search behavior. On the other hand, if the program is too rich (too many S+ samples), a great deal of time will be taken rewarding the dog for detections and also the dog's hunger will more quickly become too low for effective search. The reason for the few extra plants is that too rich a schedule can do less harm than too lean a schedule. The decision on how to program a particular area will be the responsibility of the Programmer, and how effectively he performs this duty will be crucial to keeping the dog working efficiently. If there is any doubt about the program, or if the dog's detection rate is decreasing or poor search behavior is shown, enrich the program (plant more S+ samples) and then gradually make the program leaner.

S+ samples should be planted in all types of sessions, including operational sessions. The major purpose of planting S+ samples is to keep the dog working at maximum efficiency. The reason it keeps working is that it is very rewarding to the dog each time it detects the S+ odor. If there were no S+ stimuli to detect, the system of rewards under which the dog was trained would no longer be in effect, and the searching behavior would gradually deteriorate. If the S+ samples were planted on all types of sessions except operational sessions, the dog would eventually learn to remain efficient in all types of sessions -- except operational sessions! A second purpose is to evaluate the dog's efficiency on a given session. This is especially important for those operational sessions in which no bombs are found. There, the detection of plants indicates that the failure to detect a bomb was probably due to the absence of a bomb, rather than to any lack of efficiency of the dog.

Operational Session.

The detector team should consist of three persons, all of whom preferably are trained to program and to handle the dog, so that the handling and also the programming can be rotated among them. An individual who is not on a given session handling the dog will start as Programmer, hiding the S+ packets in certain of the rooms to be searched. The specific tasks of the Programmers and the Handler are as follows:

a. Programmer. The initial duty of the Programmer is to ascertain quickly the size of the area to be searched and to determine the length of time which can be allotted to the dog and Handler in the area. Once this judgment is made, it is his responsibility to "flag" the area. Small colored paper tabs can be used for this purpose. They are of three colors. red, yellow and blue. A red flag indicates areas judged to be of the highest priority, to be searched most carefully and thoroughly. These are areas or objects where an actual bomb would most likely be hidden.

For example, restrooms, maid's closets, maintenance facilities are usually areas of high priority and are flagged red. Other areas which a dog could quickly search but would be time consuming for a human to search might also be flagged red. Places such as libraries, lockers, areas with a great many objects, especially if they are concealed or locked, are examples which fall into this category. All objects in hallways or in other areas which are easily accessible to visitors are also flagged red, along with any strange object or one which is found where it does not appear to belong. A yellow flag means an area of low priority to be searched as time allows, while a blue flag denotes an area that can be bypassed.

The Programmer must decide how to search the area most efficiently on the basis of the size and the complexity of the area and the time which is available.

It is during this initial investigation that the placement of the S+ samples is carried out. The immediate area in which the S+ sample is hidden is searched out by the Programmer prior to the S+ placement. This is done to insure that there is not an actual bomb where the S+ is placed; otherwise, the dog's response to an actual bomb might be confused with the response to the S+. It may be helpful for the Programmer to use a portable tape recorder to note the location of each S+, as well as any other information needed for the later evaluation of the dog's performance. After programming a portion of the area, the Programmer returns to the dog and Handler, and accompanies them as they search the area he has programmed. When the dog sits, the Programmer says YES if he has hidden an S+ there, and NO if he has thoroughly searched that area but has not planted an S+ there. If he has not planted an S+ where the dog is sitting, a possible bomb is indicated, and the appropriate steps are taken. For each room the Programmer records detections, false sits, time spent searching, as well as any information which will be needed for the later evaluation of the session. While the rooms which have been programmed are being searched, the third individual takes over the duties of Programmer for the next set of rooms to be searched. When he returns, the previous Programmer becomes the new Handler, and the previous Handler leaves to program the next set of rooms.

b. Handler. The Handler first locates a central area which will be used as a base of operations. This will allow the Programmer to proceed in his preliminary investigation and his planning of the course to be taken by the Handler and detector dog.

How the room is searched is the responsibility of the Handler. It is better to go into many rooms briefly than to spend all the available time in a few of the rooms, since if there is a bomb in the area a dog has a good chance of finding it rather quickly. It should, however, actively search through the room and should specifically check the places marked by the Programmer as most likely to have an S+ present before leaving.

The dog has been trained to work on- or off-leash, so the Handler can choose whether the search can be most effectively conducted with or without the leash. In either case, the dog should be allowed to go its own pace, even though this pace may often seem too fast. However, the Handler can direct the dog to return and search a particular section of a room or a particular object that he feels has not been searched. He directs the dog by moving to the area or object and giving the search command. He should be careful to use this procedure sparingly, or the dog will learn to wait for directions instead of continually searching the entire area without prompting.

Maintenance Session.

Maintenance sessions are somewhat like advanced room search. The odors planted include Hex as well as all explosives of interest that the dog has been trained to find.

The same three-man team that conducts the operational sessions also conducts the maintenance sessions. The programming of S+ samples and the flagging of areas to indicate priorities are done exactly like operational sessions; the same applies to the handling and rewarding of the dog. The Programmer should even simulate searching for bombs while he is planting the S+ samples. In short, everything is done to make the maintenance session resemble the operational session as closely as possible.

Evaluation Session.

Evaluation sessions differ from operational sessions and maintenance sessions only in that an actual defused bomb has been hidden. The purpose of the session is to determine whether the bomb search squad would succeed in finding a real bomb.

The person hiding the bomb should not be a member of the search team. If possible, a different person should hide the bomb in each session. The actions of the Programmer and the Handler should be the same as during the operational and maintenance sessions. The individual who hid the bomb should have no contact with the Programmer or Handler until after the bomb is found.

## POOR PERFORMANCE: CAUSES AND REMEDIES

There are three main classes of problems that can be experienced in training detector dogs. They are:

1. Missed targets - Failure to detect one or more of the S+ odors.

2. False sits - The dog sits when there is no S+ odor in the area.

3. Poor search behavior -
   a. Locomotor - Dog does not move around the area to be searched.
   b. Sniffing - Dog moves around the areas to be searched, but does not sniff at objects with which he comes into contact.

There is a variety of reasons that may account for one or the other of these problems. The following is a list of some of the more likely causes associated with these problems, and a brief discussion of each problem as well as some clues as to how to deal with these problems when they arise.

Perhaps the most basic rule to follow if the dog begins to perform poorly is to revert to a simpler task; once the dog is performing well, gradually make the task more difficult. If the dog begins to make errors and is allowed to continue in the same task, its performance will probably continue to deteriorate and a great deal of remedial work may then be required to recapture the dog's previous level of performance.

### Missed Targets.

If the dog fails to sit when the S+ odor is in the vicinity, the most likely reason for the failure to sit is that the odor has not been detected. No dog will always detect all S+ stimuli which have been planted; however, a well-trained and well-maintained dog should detect a high percentage of the S+ stimuli which have been planted. In addition, a certain percentage of correct detections and, therefore, rewards must be programmed into the dog's daily working sessions. There are two ways to insure that extended periods of searching will not go unrewarded: (1) Make the item to be detected very easy to find, and (2) make the plants more difficult to find, but place several of them in the area to be searched. If it is possible, placing several difficult S+ plants in the area is the preferred practice. The reason is that detecting difficult plants requires good search behavior and thus the dog is more likely to be rewarded (by a detection) for good search behavior when the S+ stimuli are relatively difficult.

Missed targets can also result from the dog learning to rely on cues other than those of the explosive material itself; when these false cues are not available, the dog fails to detect the odor.

a. Marking. There is always the possibility that the dog will "mark" the S+ stimuli. That is, the same S+ stimuli are reused and the dog may leave a sign by licking or salivating on the material that it can detect on subsequent trials, so that it may be responding to something other than the S+ odor itself. This will result in missed targets when new stimulus materials, to which the dog has not been exposed, are used. If the detection rate is approximately the same for both the old and the new S+ stimuli, it can be assumed that the dog is responding to the S+ odor. It is essential to replace the old S+ materials with new samples frequently. This will assure that the dog is responding to the S+ odor and not to marked stimuli.

b. Following. When several dogs are trained to search for the same set of S+ samples, some dogs may learn to follow others. When an area is programmed for the dog to search, it is most convenient to test several dogs on the same program, but this entails the risk of having one dog learn to follow another and, therefore, miss targets that may not have been detected by another dog. Dogs can apparently detect a place where other dogs have sat. There is always the chance that the odor of food is also present in the vicinity of the hidden S+. Even if the dog is not depending entirely on either of these two extraneous cues, it may use either or both to orient to the general vicinity of where the S+ is hidden. If it is necessary to run more than one dog on the same program, alternate the order in which the dogs are run. If a particular dog is run first on one session, it should be run last the next session. The S+ stimulus can be moved if the Programmer is certain there will be no residual odor. For example, if an S+ is hidden in a box, the box could be moved to another location in the room. If a particular dog does well when it follows another dog and does poorly when run first or when the position of the S+ is changed, there is a strong possibility that this dog is following another dog. Steps should be taken to eliminate the opportunity to follow.

c. Human odors. The sensitivity of the dog to most odors makes it possible to train it to detect almost any type of odor. Dogs are especially sensitive to the odor of humans. It is well known that dogs can be trained to detect human odors several hours old. Training problems can arise because of this keen sensitivity.

There is always the possibility that the dog is detecting the odor of the person who prepared or planted the S+ instead of the actual S+ odor. This is especially troublesome if the S+ odor is weak. There is no great cause for concern if it is the S+ odor plus any human odor that the dog responds to, as this will be the case in the dog's detection of an actual bomb. The real problem arises if the dog is responding

to a particular human odor which is necessarily associated with the S+ odor, that is, if the dog is responding not to the explosive odor, but to a specific human odor which is consistently associated with it. It is easy to check to see if the dog is responding to the explosive odor rather than to the human odor by simply having a different individual prepare and plant the S+ and S- stimulus packets.

d. Other contaminating odors. The S+ samples often absorb odors of materials with which they come into contact. The contaminating odors are often far more potent than the S+ odor, so the dog learns to sit to the contaminants and to ignore the S+ odor component. This shows up when the old S+ samples are replaced with new ones. Frequent replacement of old S+ samples will greatly reduce the opportunity for the dog to learn to respond to contaminating odors, and will also reveal any such learning before it can become firmly established.

e. Handler cues. Any behavior on the part of the Handler, whether it is intentional or not, may affect the dog's behavior. Handler cues will become a problem if the Handler knows where the S+ is hidden in the area being searched. In other words, if the Handler knows the conditions under which the dog is working, he may unintentionally cue him. Generally, it can be assumed that if the Handler does not know anything about the placement of the S+ and S- stimuli, he will not cue the dog, and the dog will not learn to watch the Handler for cues.

False Sits.

This is a somewhat more complicated problem as there is a variety of conditions which may result in the dog sitting in the absence of an S+. When the false sit occurs, do not praise or give food to the dog. At the time, investigate the reason for its false sitting, so that the necessary precautions can be taken to see that the same problem will not recur.

It is possible that the Handler may do something to cause the dog to sit. In this case, do not reward, but repeat the command SEARCH. In most instances the dog will again begin to search the area until a detection is made.

If it is clear that the Handler did not prompt a false sit, punishment by TIME OUT should be given. The removal of a dog from a setting which affords social contact with the Handler and eliminates the opportunity for the dog to earn food is punishing to the dog. This TIME OUT period should always be preceded by NO. The use of a TIME OUT period has the same effect as physical punishment in eliminating unwanted behaviors, but it has none of the harmful effects associated with physical punishment. Therefore, if the dog makes a false sit that was not prompted by the Handler, say NO and immediately take the dog out of the search situation. This procedure has been found to work especially well in eliminating false sits.

There are several factors which may cause false sits. The following discussion gives some of the most common reasons for false sits.

a. Odor contamination. Whenever an S+ packet is handled, some of its odor may adhere to the hands and may subsequently be transferred to other objects that are handled. Such objects are said to be contaminated with the S+ odor, and may be responded to by the dog, especially if the S+ has a strong odor or the dog has become highly sensitive to that S+. Since the Handler ordinarily has no way of telling that the object is contaminated with the S+ odor, he cannot reward the dog for sitting to it. Hence, every time the dog sits to a contaminated object he is actually being trained to ignore a very weak S+ odor, which is just the opposite of what the Handler desires. For this reason, every effort should be made to avoid unnecessary handling of either the S+ or objects in the area to be searched.

b. Residual odors. After a particular odor has been placed in a certain place and then removed, it should be assumed that the odor might well remain for some time. This is referred to as residual odor. After an S+ packet has been placed in a closed place and removed, the odor that remains in the closed place may last for days. Certain materials such as paper or other porous materials may retain the residual odors for an extended period. Be sure to air out completely any place where an S+ has previously been placed, but do not assume that residual odors are thereby necessarily eliminated.

Residual odors can become troublesome if repeated sessions are conducted in the same area. Remember, if a dog responds to a residual odor, this is a correct response and should be reinforced just as if an S+ had been placed at that spot. The main problem here is that there is no way of knowing whether there is actually the S+ odor present or not, since the dog might have remembered the place from the previous day. The only good solution is to avoid running a dog where a residual odor may be present.

c. Odors similar to the S+. For any given substance that the dog has been trained to detect, there probably will be several other substances that -- to the dog -- smell much like the S+. The dog has not been specifically trained to ignore such "false" odors and is, therefore, likely to react to them as S+ odors. Hence, if the dog is punished for what the Handler regards as a false sit, it is being punished for what it regards as a correct response. This may greatly weaken the dog's future tendency to sit to "real" S+ odors, impairing its usefulness in detecting the S+ substance. On the other hand, rewarding the dog for responding to such odors will increase the range of false odors to which it will respond.

The problem is similar to that of residual odors, but is more vexing since there is no way of insuring that the "false" odors will not be present.

while petting it and talking gently to it. As the dog is brought close to the noise, give it food. Do this very gradually and do not ever force the dog to move toward the noise source.

Fatigue. There will be times when the dog will become fatigued during the training session. It may generally continue to search but its efficiency will be impaired. This will most likely result in the dog's walking around the room but failing to sniff and failing to bring its nose close to objects. If signs of fatigue are noted, give the dog a short rest and then resume the training session. For extended search periods, have water available for the dog. A single search session should not exceed one hour, and should not be continued this long if the dog shows signs of fatigue.

The best procedure of all is to avoid leaving the dog in the working situation long enough for its behavior to be effected adversely. For extended search periods, this means allowing the dog short rest periods and access to water periodically before any signs of fatigue, thirst, or poor searching are shown.

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# APPENDIX I
## DATA SHEETS - INITIAL OLFACTORY TRAINING

Experiment: SCHEDULE: ASSOCIATION OF S+ WITH REWARD

Trainer(s)

Date(s): Dog:

Notes:

| Ratio S+ - S- | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 - 1 | + | + | - | + | - | + | - | + | + | - | + | + |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | | | | | | | | | | |
| 1 - 1 | + | - | + | - | - | + | - | + | - | + | | |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| | | | | | | | | | | | | |
| 1 - 2 | - | + | - | + | - | - | - | + | - | + | - | - |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | | | | | | | | | | | |
| 1 - 3 | - | + | - | - | + | - | - | - | - | - | + | - |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| | | | | | | | | | | | | |
| | - | - | - | + | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 1 - 4 | - | - | + | - | - | + | - | - | - | - | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | - | + | - | - | - | - | - | - | + | - | | |
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| 1 - 5 | + | - | - | - | - | - | - | - | + | - | - | - |
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| 1 - 6 | - | - | + | - | - | - | - | - | + | - | - | - |
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Data Sheet No. 1

Experiment:

E(s):

Date(s): Time(s):

Notes:

Ratio S+ - S- (continued)

| | | | | | | | | | | | | |
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| 1 - 6 | - | + | - | - | - | - | - | + | - | - | - | - |
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# APPENDIX II
## DATA SHEET - SIX-CHOICE DISCRIMINATION TRAINING

Six-choice Discrimination Training: Hex: 1/16" hole

Dog: Handler: Programmer:

Date: Time(s):

| TRIAL No. | Location | S+ | S- | S- | S- | S- | S- | |
|---|---|---|---|---|---|---|---|---|
| 1 | 4 | - | +1 | | | | | |
| 2 | 7 | 0 | - | +4 | | | | |
| 3 | 9 | + | - | - | - | - | - | |
| 4 | 6 | + | - | - | - | - | - | |
| 5 | 1 | - | - | - | - | * | * | Poor search behavior (cued) continued poor search. Removed from room. |
| 6 | 9 | + | - | - | - | - | | |
| 7 | 12 | + | - | - | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
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| 20 | | | | | | | | |

NOTES:

# APPENDIX III
## DATA SHEET - ROOM SEARCH

ROOM-SEARCH PLACE:

Dog: Handler: Programmer:

Date Time(s):

Notes:

| Trial | Room | Cond. | Hex. | Dyn. | C-4 | S- | | Time/Sec. | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | +H | + | | | | | 17 | |
| 2 | 8 | - | | | | | | 27 | |
| 3 | 7 | +D | | + | | | | 15 | |
| 4 | 6 | +D | | - | | | | 25 | |
| 5 | Toi | - | | | | + | | 45 | |
| 6 | 5 | +C-4 | | | + | | | 15 | |
| 7 | 4 | - | | | | *+ | | 25 | *Handler cued the dog to sit |
| 8 | 3 | +H | + | | | | | 27 | |
| 9 | 2 | - | | | | | | 22 | |
| 10 | 1 | - | | 0 | | | | 35 | |
| 11 | 10 | +D | | + | | | * | 40 | *Dog directed to location of S+ after handler indicated the room had been throughly searched. |
| 12 | 11 | - | | | | | | 31 | |