TECHNICAL MEMORANDUM NO. 71-04

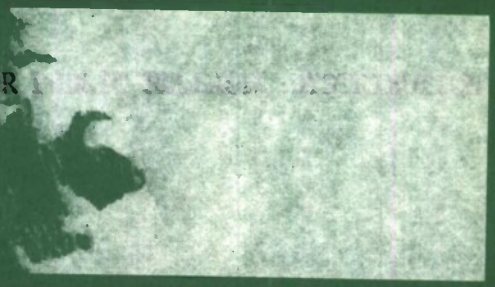
TRAINING DOGS FOR HEROIN DETECTION

Interim Report

By
JOHN J. ROMBA
Biological Sciences Branch

Technical Assistance - Thomas J. Jankowski

September 1971



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U. S. ARMY LAND WARFARE LABORATORY
Aberdeen Proving Ground, Maryland 21005

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ABSTRACT

The acquisition and maintenance of detection and search task behaviors are accomplished with positive control techniques. The principal controlling reinforcer (consequence) used is food. The dog is permitted to behave freely in the work environment without coercion and with minimal restraint. If a dog, before training, shows timidity, cowering, avoidance and "submissiveness" (orienting on handler)behavior, it undergoes desensitization to the stimuli that elicit these responses. The dogs initially learn the meaning of conditioned reinforcers. The conditioned reinforcers are then used to obtain the fundamental skills, recall, sit, stay, search chain and odor discrimination. The performance of task behaviors is gradually shaped in small steps, beginning with very simple and easily learned behaviors. A simple search model is obtained when these fundamental performances are combined. Training procedures are described in four search scenarios. The validity of the method described was established by obtaining a clear discrimination to heroin and simple search control in two dogs.

FOREWORD

The material contained in this report is largely the product of unreported exploratory work in odor discrimination and behavior control techniques with dogs performed at the U. S. Army Land Warfare Laboratory. The Memorandum was prepared in response to a request from the U. S. Army Vietnam for information on how to train dogs to detect heroin.

Central to the success of dogs to perform operationally as heroin detectors is their ability to form a discrimination to heroin and to search properly. Within the limited time period available, an attempt was made to determine empirically whether dogs could detect heroin and, to a limited extent, if good search performance for heroin could be obtained.

The subjects of this work were two recently acquired Labrador Retrievers. They were trained according to the procedures described in the report. Their odor discrimination training, though incomplete, ended with the procedures of Section III.E.2.g., when the dogs were able to detect heroin against several programmed background odors. Search training terminated with Simple Search as described in Section IV.A.

In the controlled settings of this study, both dogs showed little difficulty in learning to recognize the odor of heroin and to locate heroin in six-position discrimination search problems correctly. No information was obtained to indicate how well the dogs might perform in operational search fields containing heroin.

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I. INTRODUCTION

The method described in this report is separated into two principal parts. In the first part procedures are described by which the animal learns the required basic skills in a controlled environment. The training environment is controlled for two reasons: (1) To eliminate undesirable external influences, and (2) to provide a situation in which the trainer easily and precisely can present the critical stimuli and appropriate consequences. Under controlled circumstances, behavior acquisition is rapid and behavior stability is maintained. In the second part procedures are described by which search training is conducted using the detection behavior learned earlier to put together the final characteristics of the system.

Control of task behaviors is regulated mainly by food, petting and praise. Physically unpleasant consequences are not used because they can produce interfering avoidance and escape reactions on the part of a dog.

The method permits the dog to behave freely in its environment without coercion and with minimal restraint. Under most training circumstances, the dog is released at some distance from the work station by the trainer's assistant; it reaches the station without assistance and begins to perform the task without any urging. The dog comes to recognize the work situation as an opportunity to obtain food, and very soon the trainer himself at a work station symbolizes this opportunity to the dog. If the dog stops working or works poorly when it is capable of working better, it is because of lack of motivation. The animal is then simply removed from the training setting for a period of time.

A. ANIMAL QUALIFICATIONS.

A dog selected for training for narcotics detection should show basically the same characteristics required for the Army Scout Dog, with special emphasis on certain features. The dog should be of moderate temperament, neither timid nor overly aggressive. It should be alert and sensitive, but not easily distracted. The dog should show curiosity and have a "sensitive nose." It should also show good stamina and perseverance at its tasks. If the dog is found to be deficient in these characteristics, training should be discontinued. Dogs with prior military service in other tasks are acceptable for this kind of training.

B. ADAPTATION TO EMOTION-PRODUCING AVERSIVE STIMULI.

A dog that shows timidity, cowering and avoidance behavior, must undergo adaptation to stimuli that elicit these responses. A dog with this kind of problem may, at times, stay close to its handler or trainer

and refuse to leave his side even on the command given for it to move out. At other times the dog may stay at some distance from its handler or trainer and may not respond to the recall command. These unwanted and interfering behaviors can be the result of mistreatment. The reactions may be caused not only by the person or persons who may have mistreated the dog, but commonly by all people, including the dog's handler and/or trainer.

A mutually pleasurable association between the handler/trainer and the dog should be established as a basis for carrying out this adaptation process. Initially the dog is kept on a 20-foot leash. In the first 2 or 3 sessions the trainer generally ignores the dog while he leisurely moves about, reads, or otherwise occupies himself. He may occasionally speak to the dog and even try to touch it lightly. The trainer must not show annoyance with the dog or give it any commands at this time. In subsequent sessions the dog is released from the leash for short periods of time and the trainer progressively gives more attention to the dog until finally he is engaging in playful activity with it. The trainer waters and feeds the dog at the end of each session. The sessions can each last from 30 minutes to one hour.

C. FOOD REINFORCEMENT AND BEHAVIOR.

In this task, the dog receives a food pay-off for work output. It should be understood, however, that none of the behaviors are brought under the control of food directly. Behavior control actually is exercised by so-called "conditioned reinforcers," of which the words GOOD, NO and CHOW are the principal ones. A conditioned reinforcer is a stimulus which has no meaning to an animal before it has been associated with another reinforcer, such as food. Money is an example of a conditioned reinforcer -- it controls the behavior which produces it. An individual learns that money is of value when he finds that he can exchange it for things he wants. The word GOOD, in a sense, is equivalent to food or to the promise of food to the animal.

The word GOOD attains reinforcing properties only after repeated pairings with food. Studies have shown that a food-associated conditioned reinforcer, such as GOOD, will cause an animal to salivate but not nearly as much as would be caused by the food itself. The trainer can occasionally detect an onset of mouth watering in an animal within seconds after he delivers the conditioned reinforcer, GOOD. Because the word GOOD is paired with food, which acts as a desirable or rewarding consequence to a particular behavior, GOOD is called a "positive" reinforcer.

The reinforcer GOOD increases the frequency of a behavior if the behavior immediately precedes it. The reinforcer NO also can increase the frequency of behavior. The increase in frequency is obtained whenever

the behavior avoids turning on the word NO. Thus a behavior can occur with ever greater frequency if it turns on the word GOOD or because it avoids the word NO. NO can be used in another way -- as punishment. The NO then decreases the frequency of a behavior it follows. If the word NO is to be effective as a reinforcer or as punishment, it must be paired repeatedly with an unpleasant stimulus. Examples of unpleasant stimuli are electric shock, pull on choke chain, food withdrawal, etc. In this training the NO will be paired most often with food withdrawal.

The word GOOD is followed by a small portion of the animal's daily food ration or by no food at all. The word CHOW replaces the word GOOD as the last reinforcer given on any day. CHOW is followed by the remainder of the animal's daily ration. The large final food portion is called goal food. It should be made more palatable than that obtained in other parts of the training.

The conditioned reinforcers will not obtain or maintain behavior unless the animal is hungry. A food deprivation schedule must be maintained throughout the program. The animal is not fed for 18 to 24 hours preceding each day's training program.

Starting two weeks before the dog begins training, it is fed 30 to 50 percent more food than usual each day until the weekend preceding the start of training. At this time the dog is given no food at all for a period of about 72 hours immediately preceding the start of the first day's training program. During the learning of task fundamentals, a pellet of food is given the dog following the reinforcer GOOD every time. When the dog is in the simple and specialized search training phases, food will gradually be faded from the trials except for the goal food, which will remain.

D. SCHEDULE OF TRAINING.

The performance of a particular behavior is gradually shaped in small steps, beginning with very simple and easily learned behaviors. Each animal learns at its own learning speed. It does not proceed to another step in training until it has learned to a desired level at an earlier stage. Every animal goes through all the training outlined in this guide, regardless of its former experience.

The procedures described here are designed to give the animal extensive experience in a multitude of task behaviors within a short period of time. The fundamental skills can be brought together to form the simple search task at about the third week. The animal can become operational to perform the specialized task of parcel search after about three months of training. Building and vehicle search capability can be obtained in another 2 to 3 months.

1. Preliminary Adaptation.

a. Familiarization with trainer. For 2 weeks before formal training begins, the trainer spends 1/2 to 1 hour daily with each dog establishing a friendly and enjoyable association.

b. Food scheduling. The dogs are given a larger than normal food ration for 12 consecutive days beginning 2 weeks before the start of training. They are not fed on Saturday and Sunday preceding the first training day.

2. Conditioning of Reinforcers.

a. The reinforcer GOOD. Training begins on Day 1 of Week 1. Conduct 2 sessions on the first day and 1 session on Day 2 for a total of 3 sessions training time. Session duration is 10 to 15 minutes.

b. The reinforcer NO. No sessions are devoted exclusively to this learning. It is introduced at the time of simple search and its use is continued thereafter on all tasks.

c. The reinforcer CHOW. Training begins on Day 2 of Week 1 at the termination of the last recall training session. It continues to be programmed for the last session on each training day, unless the last session of the day is abruptly terminated because of poor performance.

3. Conditioning Fundamental Behaviors.

a. Recall. Training begins on Day 2 of Week 1 after conditioning the reinforcer GOOD is completed. Two sessions are conducted indoors -- one session each on Day 2 and Day 3. Thereafter, training continues on an informal basis both indoors and outdoors.

b. Sit. Sessions begin on Day 1 of Week 2. One or two sessions are conducted daily until good control is obtained.

c. Stay. Training is conducted at times during which the animal is required to maintain its position.

d. Search chain. This training is begun on Day 3 of Week 1. Two sessions are conducted every day until the end of Week 2, or until simple search training begins. A session lasts about 10 minutes.

e. Odor discrimination. Training is begun on Day 3 of Week 1. One or two sessions are conducted every day for the duration of training. Session duration is between 10 and 15 minutes.

4. Search Training.

a. Simple search. Training starts on Day 1 of Week 3, or when the required fundamental behaviors have been learned. One session is conducted per day for the duration of training. A session lasts about 10 minutes.

b. Specialized search. Training begins on Day 1 of Week 7 and continues for the duration of training. One session is conducted per day and it lasts from 10 minutes to 1 hour.

II. CONDITIONING OF REINFORCERS

A. GOOD.

If a stimulus that is effectively arousing a given response is frequently preceded by or paired with an ineffective neutral stimulus, that neutral stimulus will eventually produce the given response. Food arouses the response, salivation, without learning. After pairing the word GOOD with the stimulus food a number of times, the GOOD itself begins to take on some of the same properties which food has. The test of conditioning during this training, however, will not be whether the GOOD, when presented alone, can indeed elicit salivation, but will be tested as a reinforcer to determine if it can bring some simple behavior under control.

1. The Pairing Procedure.

Food pellets, such as Prime, and a food bag are necessary to conduct this training. The food bag can be made out of canvas and should have a strap which either attaches around the trainer's waist or goes over his shoulder. The U. S. Army Claymore Mine bag is ideally suited.

The trainer stands in one position for the early trials. One hand rests in the food bag between trials. For the first 3 trials, the trainer will remove a food pellet from the bag and immediately place it into the dog's mouth. He does this at 10 second intervals. By the time the third pellet is given, the animal probably will be oriented toward the trainer in a begging posture. The orientation assists in obtaining the relationship between the word GOOD and the food. The relationship is more readily grasped by the animal if it sees the events as they occur in sequence. The next twelve trials are conducted in the following manner: The trainer says GOOD, the hand comes out of the food bag, body bends and hand lowers to knee level, hand opens, food is revealed, etc. The trainer's movements are smooth and purposeful and he does nothing to startle the animal. The trainer must do nothing to "tip off" the dog that the GOOD is coming. It will take some practice to start making food delivery movements ONLY after the GOOD is spoken. Between trials, the hand in the food bag must remain in a resting position without movement, otherwise these movements may cause anticipatory responses by the animal. Intervals between trials vary at random between 10 and 30 seconds.

In the next 24 trials, the paired reinforcers are presented only when the dog is not orienting toward the trainer, or at least when it is not looking at him. The trainer now is eliminating ("extinguishing") the orienting behavior because the paired reinforcers no longer are

given in its presence. The pairings must also be delivered independently of any other specific kind of behavior. Before the reinforcers are presented, the dog must be doing something different every time. For these trials the trainer walks about slowly within the enclosure or room. The trainer may note a similarity in the way the paired reinforcers and the recall command COME operate on behavior. At this stage, the dog quickly returns to the trainer whenever the GOOD is sounded, just as it will later respond to the command COME. The functions of the reinforcer GOOD and the command COME will later become clearly differentiated.

2. Testing the Reinforcing Property of GOOD.

A reinforcer is effective if it increases the appearance of a behavior it follows. To test the effectiveness of the reinforcer GOOD, the trainer can select any simple behavior which may appear spontaneously, such as movement toward the water bucket, any movement away from the trainer, nose touching the floor, etc., and deliver the word GOOD when that behavior occurs. Behaviors which are short-lived should not be chosen unless the trainer has the experience to time precisely the word GOOD with the exact behavior as it appears. The animal will probably not perform in the same way from one time to another, so the trainer should reinforce reasonably close approximations of the selected behavior. In a short while the animal will be doing only those things which are being followed immediately by the reinforcer GOOD.

The trainer can, if he wishes, take the time to condition additional simple behaviors, each in turn. As one behavior is being acquired, another is being extinguished. A behavior will be extinguished whenever a conditioned response occurs and the reinforcer is withheld. It is not unusual for a behavior to come under reinforcer control within a very few minutes of repeated trials.

B. NO.

The reinforcer NO is formally introduced at the time of simple search training and its use is continued thereafter.

No separate conditioning is made with the word NO. It is learned along with other things. In task training NO will be followed by a momentary or extended period during which food is not offered to the dog. Food is withheld whenever the negative reinforcer NO is given, as a consequence of an incorrect or undesired behavior. Immediately thereafter, the dog is given another opportunity to perform the correct or desired behavior. When a dog has learned a particular task or behavior well, however, it can occasionally be removed from the training situation immediately following a NO for periods of from 10

minutes to 24 hours. In such a case, of course, the dog does not have an opportunity to perform the desired task or behavior correctly and thus earn food reinforcement; it cannot work for food until it is returned to the training situation. In the interim it receives no food.

The trainer should be alert for occasions when he can pair the word NO with physical punishment, but he should not deliberately create these occasions. If the pairing is done properly and with restraint, the animal should not become hand-shy or trainer-shy. Three examples follow: (1) A dog on-leash shows aggression toward another animal or toward a person. A firm NO is sounded followed by a sharp jerk on the leash 1/2 second later. (2) The dog urinates in the test enclosure or room. A firm NO is immediately given, followed in 1/2 second by a sharp swat across the dog's rump. (3) The animal pushes its nose into the food dish before the food is fully prepared. Here, the NO is followed in 1/2 second by a firm swat across the dog's mouth. In every case the NO is sounded at the moment the behavior occurs and is followed closely in time with the appropriate physical punishment.

The sequence of events associated with negative reinforcement by the word NO can be summarized as follows: Except at those times when the animal is removed from training after receiving a NO, the NO is always followed by a command, e.g., NO...COME; NO...SEARCH; NO...STAY; etc. Upon occasions when the training session is abruptly terminated because of errors or incorrect behavior, the trainer sounds NO and immediately moves toward the animal. The trainer takes the first step only after sounding the NO. The animal is taken away on short leash and staked out.

The NO is never sounded loudly, harshly, or with emotional impact when the animal is working in the training situation.

C. CHOW.

Following the last trial of the day, the word CHOW is given in place of the reinforcer GOOD. CHOW means that the balance of the daily food ration is about to appear all at once. This signal provides a connection for the dog between its test performance and being given a pan full of food (goal food), even though the interval between these events may be minutes long. With these procedures the animal learns that all its food is earned by work.

When the goal food is first used as such, it should follow the reinforcer, CHOW, closely in time. In the first week, the food pan is prepared ahead of time and set aside close to the place of training. After saying the word CHOW, the trainer runs to where the food pan is hidden, retrieves it, and places it in front of the animal. All the while, he continues to voice the word CHOW at about 2 second intervals.

After repeated presentations, the delay between the two events, i.e., the word CHOW and presentation of the goal food, can be gradually increased with no decrease in behavior control by the reinforcer CHOW. Soon the word CHOW will have the profound effect of arousing the animal to a high state of excitability every time it is given. And the animal will often run ahead of the trainer to where the food is usually kept and wait there. When these effects are noted, the trainer can give the word CHOW once, take his time getting to the place where the food is kept, and then leisurely prepare the food in the pan. The goal food can consist of one can of all-beef Alpo mixed with a portion of Prime.

As mentioned in the section on conditioning of the reinforcer NO, the test session is sometimes abruptly terminated immediately after incorrect or poor performance brings on a NO. When this is done, what in fact is occurring is that the NO is being followed by a period of time-out from a food-working situation. A time-out can be as brief as 10 minutes or it can be as long as 24 hours. In any event the animal soon learns that during a time-out it will not receive goal food. The animal also learns that if it can prevent a time-out from occurring, i.e., by performing adequately in the test situation, it will receive goal food. Not more than one 24-hour time-out should be given a dog in any one training week. During a 24-hour time-out the dog is fed only the amount of Prime it would normally earn in that day's training session, up to a maximum of 2 bags.

III. CONDITIONING FUNDAMENTAL BEHAVIORS

A. RECALL TRAINING.

Excellent recall control must be established because almost all training is conducted in the off-leash mode. Control by the stimulus COME implies that the animal understands the signal, and will go to the person who calls when the call is made. Food will be forthcoming only when the correct response closely follows the signal COME. If the dog delays its response more than 3 seconds after the recall is sounded, it is not reinforced.

Recall training begins after conditioning of the reinforcer GOOD is completed. The work is conducted within an enclosure. The trainer gives the command COME at any time when the dog is moving away from him. If the dog returns, the reinforcer GOOD and food follow in the same way in which they were paired during conditioning of the reinforcer GOOD.

This training raises a rather subtle point. The word COME may actually be operating more as a reinforcer than as a unique stimulus, i.e., movement away from the trainer turns on the word COME, followed by GOOD and food; hence, the COME itself acquires reinforcing properties. If this is the case, advantage is thereby derived because the dog will tend to move out more readily to increase the chances for recall.

Sometimes the probability of obtaining the full return behavior at the start of recall training is near zero. To bring about the response more quickly, the trainer can shape the desired response out of a mass of random behaviors being shown by the animal. Shaping is accomplished by the process of successive approximations. The trainer selects for reinforcement those behaviors which will more and more closely lead to the desired response. Thus, he can reinforce head turning as the first approximation response. The probability that the dog will turn its head reflexively at the sound of the word COME may be quite high. If the head does turn, the trainer immediately reinforces this movement with the word GOOD and shows the dog a pellet of food. The trainer times the conditioned reinforcer GOOD to appear simultaneously with the head turn. After a few trials, the response to be reinforced is redefined as "total body turn toward the handler." Then reinforcement is not given unless and until the dog turns its entire body toward the trainer. In this way the animal gradually approximates more completely the desired form of response until the return is being made. Finally, this and no other behavior will be reinforced.

At the same time the dog is being trained to return on signal, return without the proper signal is undergoing extinction. If the animal returns to the trainer in the absence of the command COME, no reinforcement

is given. Continued return without reinforcement causes the behavior to weaken until it occurs only infrequently, if at all. Following unauthorized returns, the trainer ignores the animal. He will not even touch it, because even a touch is reinforcing.

Recall training is conducted within an enclosure until good control is established. When outdoors, the recall signal should be used sparingly. If the dog returns correctly on signal, it is given the reinforcer GOOD, one cube of food and about two seconds of petting. If no response is made to the command COME, then the trainer may repeat the command. If still no response is made in the next three seconds, the trainer says NO and fetches the animal. Then the animal will be walked on short leash for a few minutes. Fetching is the only negative consequence used in outdoor training.

B. SIT TRAINING.

The sit response is used as the primary indicator of detection. When the dog finds the source of a designated odor, for example, heroin, it will immediately assume a sitting position. In addition to the designated odor, a touch on the rump and the word SIT will also be signals for the response, SIT. The touch on the rump will be learned first. It will then aid in conditioning the word SIT.

To start, the dog on-leash stands in front of the trainer with its hind legs positioned straight down. The dog cannot readily sit if its hind legs are extended back rather than being straight down. The trainer holds the leash in his right hand.

The first procedure used to obtain the sit response is called "escape conditioning," utilizing an unpleasant stimulus. Downward pressure on the dog's hips is the unpleasant stimulus, even though the pressure is not a heavy one. If necessary the trainer also gently pulls back on the leash while putting pressure on the hips. At first the dog may resist the pressure, but with persistence in applying the pressure, the resistance weakens. The animal then turns off or escapes the unpleasant stimulus by yielding to the pressure in the direction it is being applied.

The trainer should not show any emotion during this training. The animal should never be forced into the sit position. The animal should be given every opportunity to make even partial responses voluntarily, if not the sit itself. At first any voluntary movement toward the sit is immediately reinforced with GOOD. When the rump touches the ground, the dog is again reinforced with GOOD, followed with some brief petting. When the dog has reached a full sitting position, it is kept in this position for about 10 seconds. It is then led away to another spot and the process is repeated. The unpleasant pressure soon becomes refined to merely a light finger touch on the rump. When the animal

sits in response to a finger touch, the reinforcer GOOD and a little petting follow. If the dog sits before the signal is given, it is lifted back up to the standing position. During training on this task, the dog sits only in the presence of the signals, and stands at all other times.

Training the dog to sit to the spoken command SIT is a simple matter when the behavior is already being performed in response to a finger touch. The new signal, SIT, has only to precede the onset of the finger touch by 1/2 second in a number of pairings. The response then comes under control of the new signal. The reinforcer GOOD and brief petting follow correct performance.

After the dog has learned to sit on hearing the command SIT, the leash is removed and sit training is continued off-leash. At first the trainer keeps the dog in front of him where he can give the finger-touch signal as well as pronouncing the command SIT. When the dog is responding well to the spoken command alone, then the trainer will increase the distance between himself and the dog until the dog is responding correctly to the SIT command at a distance of 15 feet. If the animal fails to respond correctly to the command given at a distance, the trainer says NO in a normal voice, walks purposefully but deliberately to the dog, applies the touch signal, and obtains the sit response. While this training is going on, the trainer may introduce the command STAY.

C. STAY TRAINING.

The command STAY means "maintain position." The STAY will be used most often to maintain the dog in the sitting position. It is usually given when the animal has just completed the response so that the word GOOD, used in reinforcing the response, comes to be sounded almost in the same breath with the command STAY. The correction for breaking from a maintained position is NO...STAY.

D. SEARCH CHAIN TRAINING.

Search is accomplished most efficiently if the animal automatically executes the required behaviors in a chained sequence. A behavior chain is described as a succession of learned behaviors in which one behavior produces cues which are essential to the next, until the last response produces food reinforcement.

The search chain begins when the animal comes to the trainer, then circles around the trainer's right side and back, and comes to a stop at the trainer's left side. A final movement is made away from the trainer toward the food pan. The chain ends when the dog obtains the food. Search chain training is complete when the dog is smoothly performing the behaviors illustrated in Figures 1, 2, 3, and 4.

FIGURE 1. Search Chain Training: Start of Chain.

FIGURE 2. Search Chain Training: Circling around Trainer.

FIGURE 3. Search Chain Training: Moving Out from HEEL.

FIGURE 4. Search Chain Training: Terminal Point (Feed Pan).

The search chain is progressively developed by combining small increments of simpler forms of behavior. One small behavior increment is mastered before the next is attempted. The training steps follow:

1. An association is formed between food and the pan. While on leash, the animal is walked several times past a pan which contains one pellet of food. The trainer's assistant stands close to the pan and places a single pellet of food into it at appropriate times. The dog is ready for the next step if it goes unhesitatingly to the pan from a distance of about 10 feet.

2. The leash is no longer used. The dog is released about 10 feet from the pan. The trainer waits at the point of release until the animal has eaten the food pellet. He then goes to the dog, grasps it lightly by its collar, and leads it back to the starting point. This procedure is continued until the dog moves quickly toward the pan when released.

3. A new conditioned reinforcer is introduced to aid in obtaining some of the chain behaviors more quickly. A sound is made by the food pellet when it hits the pan from a height of 3 to 5 feet. The "plunk" sound occurs at the moment the dog is performing a selected action. The first behavior to be reinforced in this way is movement away from the pan. The dog is led away from the pan with a light hold on the collar. When the sound is heard, the collar is immediately released. In a few trials, the trainer will find that he no longer needs to hold on to the animal -- it readily accompanies him away from the pan. The dog may impulsively leave the trainer's side and go to the empty food pan without the signal first occurring. It is permitted to do so. Then the dog is brought back as before. Training is completed when the dog will accompany the trainer away from the pan until the signal is heard, when it then turns back to the pan.

4. The dog makes a circle around the trainer before going to the pan. The trainer stands facing the food pan which is about 20 feet away. He gives the command COME. When the dog reaches him, he lightly pulls the animal by the collar around his right side and back. When the dog is in the back turn, as shown in Figure 2, the food pellet hits the pan with a "plunk." The animal continues to move around the trainer's left side and to the food pan. After a while the trainer will no longer have to recall the dog -- it will promptly return after it eats the food from the pan. He can also fade out leading the dog around him. This step is complete when the dog moves smoothly through the chain behaviors shown in Figures 1, 2, 3, and 4.

5. The dog is required to come to a stop at the trainer's left side (HEEL position) and to wait there until it receives a signal to move out again. The signal that denotes release from the HEEL position is a light forward push on the collar. The trainer grasps the dog's collar as it

comes around his left side and holds the dog for about one second before letting it go to the pan for the first six trials. The trainer then varies the time the dog must stay at HEEL from one to four seconds. As the dog begins to stop pressing forward during the hold interval, the release-from-hold signal gradually becomes the "light forward push on collar."

6. The precise positioning of the animal at HEEL is learned. When the dog first begins to stop voluntarily at HEEL, no attempt should be made to position it correctly. Later, the first correction to be made is for stopping too far away from the trainer. This behavior can be shaped. For instance, it may be noted that the average stopping distance is 3 feet. To begin, the trainer permits any stops made closer than 3 feet. For any stops beyond that distance, the animal is gently led by the collar around the trainer again and stopped in the correct position. When the trainer sees that the average stopping distance has become, say, 2 feet away, he corrects only those distances that are made further than 2 feet. The process is continued in this manner until the separation between trainer and dog is no greater than about 6 inches. The next correction may be made for stopping too far in front of the trainer. This fault can also be corrected with shaping. Learning comes about more quickly and with better results when the changes from one learning step to another are small ones.

7. The animal learns to move out on the command SEARCH. After HEEL behavior is being made correctly, the light push forward on the animal's collar is preceded by the word SEARCH by about 1/2 second. With continued pairing in this way, the word SEARCH by itself will release the animal from HEEL. These two conditioned signals (SEARCH and light push on collar) can then be used either together or separately, as desired.

E. ODOR DISCRIMINATION TRAINING.

In odor discrimination work the animal learns that certain odors have positive reinforcing properties because they are closely associated in training with positive conditioned reinforcers and food. The method described here, through rigid control of the discrimination field, obtains valid and reliable odor discrimination with relative ease. The present method also identifies olfactory thresholds, and enables one to ascertain a dog's olfactory discrimination stability over a period of time. Odor discrimination training is not dependent on the learning of any other task behavior.

1. Method.

Figures 5 and 6 show the setting for two-position discrimination training. The six-hole stimulus board, made for use in the later simple search test, is also used in the present work. The stimulus board is

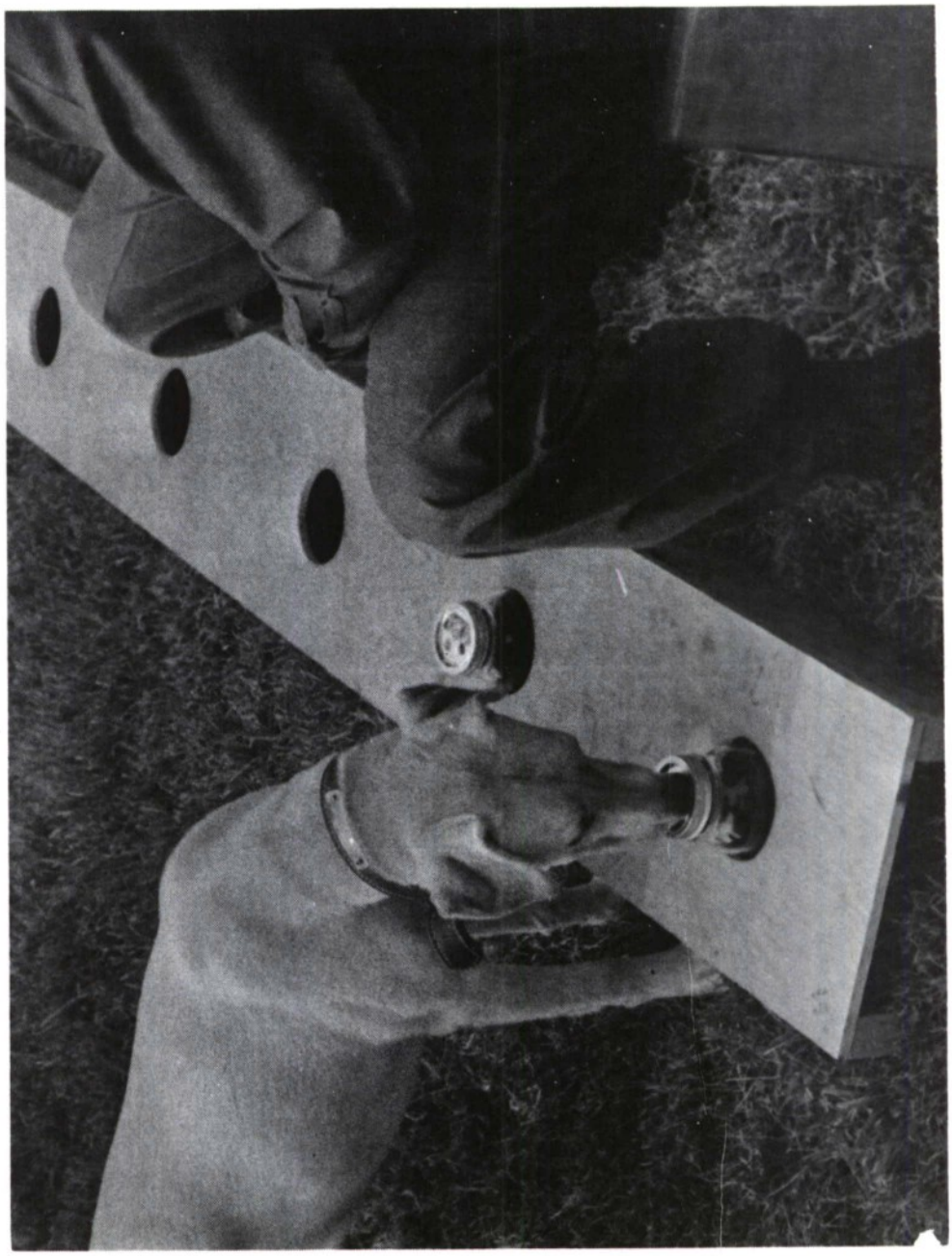

FIGURE 5. Odor Discrimination Training: Sampling the Odor Jar.

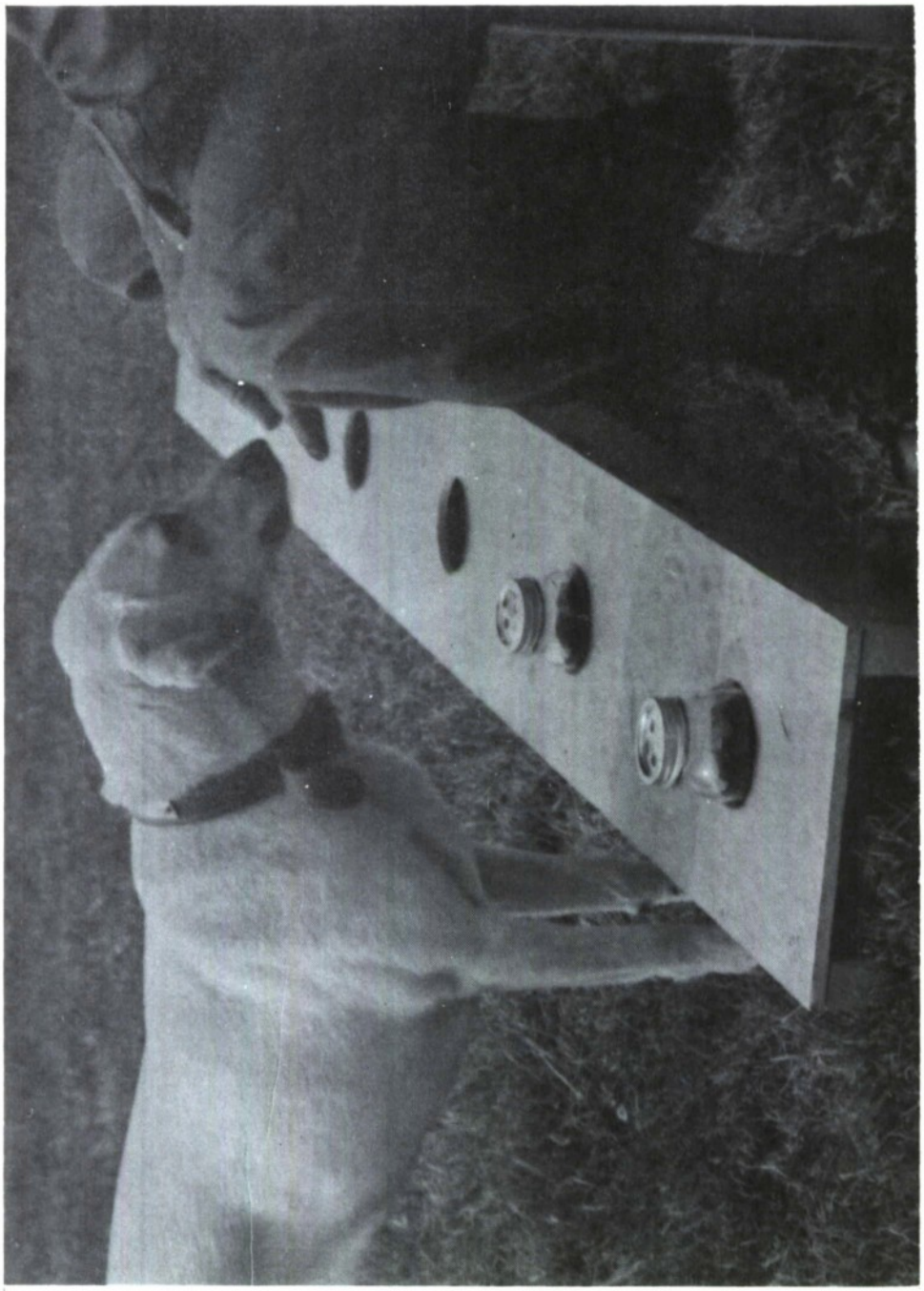

FIGURE 6. Odor Discrimination Training: Reinforcement.

constructed of plywood and lumber with overall dimensions of 4 inches by 12 inches by 108 inches. Six holes spaced 18 inches apart are cut into plywood to receive the test jars. Two jars are placed in each of 2 adjacent holes in the board. The trainer sits facing the board on a stool or box about 12 inches high.

The trainer is already seated at the board and has the first pair of jars in place when the dog arrives. The assistant releases the animal from where it has been staked out and allows it to reach the work station by itself. The assistant records the data.

a. Materials used in odor discrimination training.

Quantity	Items
1	Graduated cylinder, 10 ml
1	Graduated cylinder, 100 ml
8	Container, 1/2 gallon (jug or similar)
100	Jar, Mason, quart, with holes in lid
2	Funnel, glass, long stem
1	Glacial acetic acid, pint
500	Filter paper, medium fine, 6-8 cm diameter
100	Test tube, 4 inches, w/cork stoppers
	Test tube holders
1	Pure heroin, 3 gms
1	Pencil, glass marking
2	Forceps, small, stainless steel
2	Forceps, large, stainless steel
1	Spatula, stainless steel
	Tap water
	Common background materials: Newspaper, wrapping paper, string, masking tape, glue, plastic bags, clothing, leather, plastics, wood, earth, sand, flowers, food, etc.

b. Preparation of acetic acid stock solutions. Label the 8 jugs with the following numbers: 0, 2, 3, 4, 5, 6, 7, 8. These solutions are identifiable as to strength by the numbers. The jug labeled 0 contains only water. The other numbered containers identify the number of zeroes in the number of parts water to 1 part acetic acid. For example, the container 6 solution is 1,000,000 parts water to 1 part acid. The higher the number, the weaker the solution -- the exception, of course, is number 0. The preparation of solutions from one time to another should be uniform. Keep cork stoppers on all jugs at all times during storing and mixing to avoid loss of strength by evaporation of the acid. Stock solutions should be made up fresh at the beginning of each week as follows:

Container 0: Add 1,500 ml plain water. It is used in the negative jars.

Container 2: Add 10 ml of glacial acetic acid, using the 10 ml graduate, to 1,000 ml water (measured with the 100 ml graduate). Swirl the container for about one minute to mix the solution thoroughly; rinse graduates. (This solution is used only in mixing other solutions, not in training.)

Container 3: Add 100 ml from container 2 to 1,000 ml water. Swirl solution and rinse graduates.

Container 4: Add 10 ml from container 2 to 1,000 ml water. Swirl solution and rinse graduates.

Container 5: Add 10 ml from container 3 to 1,000 ml water. Swirl solution and rinse graduates.

Container 6: Add 10 ml from container 4 to 1,000 ml water. Swirl solution and rinse graduates.

Container 7: Add 10 ml from container 5 to 1,000 ml water. Swirl solution and rinse graduates.

Container 8: Add 10 ml from container 6 to 1,000 ml water. Swirl solution and rinse graduates.

c. Preparation of heroin samples. Wash hands and rinse thoroughly. Label 50 test tubes with a plus mark (+) and 50 test tubes with a minus mark (-). Fold 50 pieces of filter paper as shown in Figure 7. Place these inside the test tubes marked with the minus mark. Place 1/20 gm (50 mgm) heroin (a small mound approximately 3/8 inch in diameter) on each of 50 filter papers. Spread the pile out with a spatula to the middle 3/4 of the paper. Fold as in Figure 7, being careful not to spill any of the powder inside the 50 tubes marked with the plus mark. Wash hands again and rinse thoroughly. Samples are prepared fresh as often as the supply of heroin permits. Two weeks is about as long as any heroin samples should be used in the training.

d. Preparation of Mason jars. Mason jars will be used in pairs, with one jar plus and one jar minus. The contents of the plus jar will determine the contents of the minus jar in any pair as shown in the following table.

Plus (+)	Minus (-)
Acetic acid	Water
Acetic acid and heroin in (+) test tube Or Water and heroin in (+) test tube	Water and (-) test tube

Plus (+)	Minus (-)
Heroin in (+) test tube	(-) test tube

All jars are prepared on the day of training. The preparation of jars is as follows:

Acetic acid: Carefully pour 30 ml of solution through glass funnel into the Mason jar marked with a plus sign. The glass funnel used for stock solutions is marked with a plus sign.

Acetic acid and heroin: With long forceps, the test tube containing heroin is carefully placed into the jar containing acetic acid solution.

Heroin and water: Carefully pour 30 ml water from container 0 through glass funnel marked with a minus sign into a Mason jar marked with a plus sign. With long forceps, the test tube containing heroin is carefully placed into the jar containing water.

Heroin: With long forceps the test tube containing the heroin is carefully placed into an empty Mason jar marked with a plus sign.

Water: Carefully pour 30 ml water from container 0 through glass funnel marked with a minus sign into a Mason jar marked with a minus sign.

Water and negative test tube: Carefully pour 30 ml water from container 0 through glass funnel marked with a minus sign into a Mason jar marked with a minus sign. With long forceps, the test tube without heroin is carefully placed into the jar.

Negative test tube: With long forceps, the test tube without heroin is carefully placed into a Mason jar marked with a minus sign.

2. Steps in Odor Discrimination Training.

a. Shaping nose presence at mouth of jar. Before discrimination training can begin, the dog must learn to put its nose in places where the odor of interest is found. Odors to be used in discrimination training will be presented to the dog in wide-mouth one-quart glass jars. The dog has to learn to place its nose at the mouth of the jar or within the opening. Either response is correct. The training setting is shown in Figure 5.

Acetic acid, which has an easily discriminable odor, is used to provide the stimulus odor in early discrimination training. For the

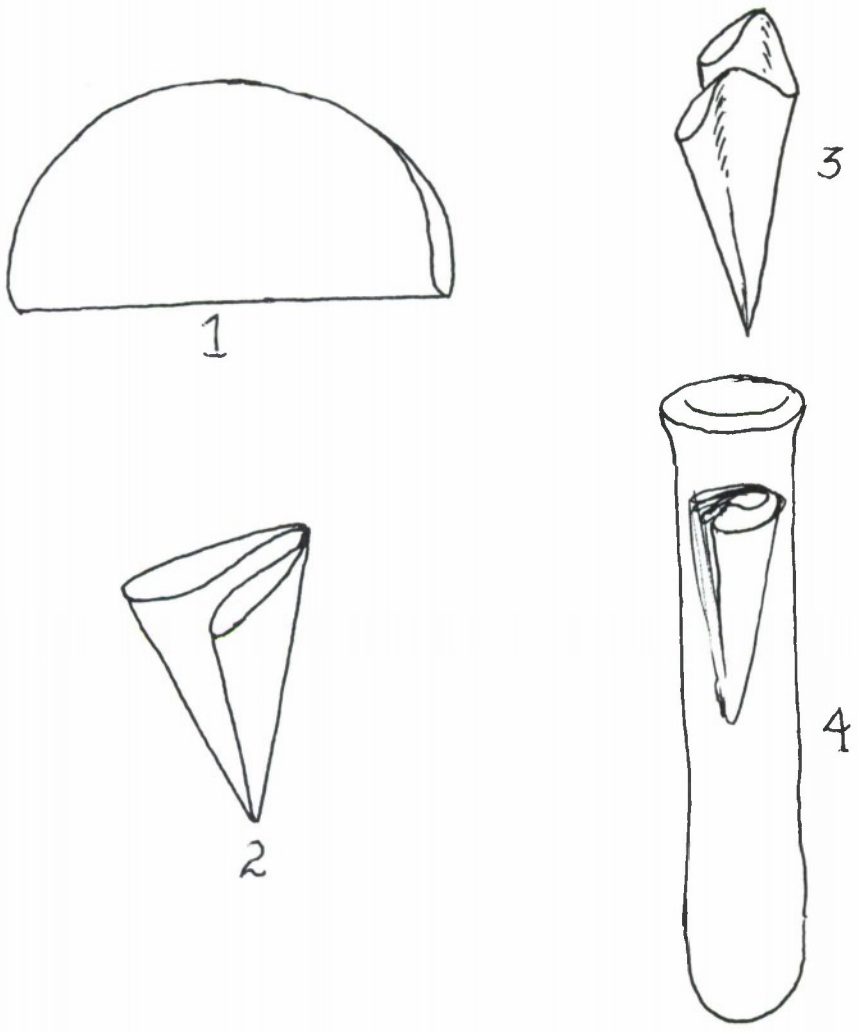

FIGURE 7. Preparation of Test Tube with Filter Paper.

first step each jar contains one ounce of a solution of one part glacial acetic acid to 1,000 parts tap water. Both jars, therefore, are positive in this step.

The trainer is already present at the work station when the dog is released close by. If the discrimination work is to be a success, the dog must approach the work station unhesitatingly and begin immediately to attend fully to the programmed stimuli. The dog should not show avoidance behavior toward the trainer. If it does, appropriate efforts to eliminate that behavior should be taken (see Section II.A.2.).

The trainer must be careful not to distract the animal while it is working. He does not talk to the dog or touch it. He sits quietly facing the animal. One hand rests in the food pouch. Random movements of the hand within the bag must be avoided because such movements especially divert the dog's attention from the task at hand. When the dog makes a correct response, the trainer immediately reinforces with the word GOOD, followed shortly by the delivery of one food pellet to the dog. The hand then goes back into the bag to await another reinforcement action.

In the first session of discrimination training the dog may not approach either jar immediately. It is highly probable, however, that the dog will soon spontaneously approach one of the jars to investigate it with its nose. Should the dog place its nose at the opening of either jar, the response is then immediately reinforced with the word GOOD and followed by a food pellet. As a result of the connection made between the described behavior and the reinforcer GOOD, the behavior will be likely to appear with ever greater frequency.

Not all dogs may engage in investigatory sniffing when they are first introduced to the training situation. In cases where the desired behavior does not occur spontaneously, it is necessary to shape the response, or condition the response in successive steps which approximate more and more closely the response of ultimate interest.

(1) Conditioning nose at jar by the method of successive approximations. If a dog fails to investigate either jar spontaneously within 5 seconds after the test session is begun, then nose at jar is conditioned in small steps by reinforcing those behaviors that successively bring the nose closer to the jar opening. For the first approximation, any movement of the head downward toward the jars is immediately reinforced with the word GOOD. When this response is observed to increase in frequency as a result of several reinforcements, the trainer reinforces successively closer movements toward the jars until the nose is touching any part of either jar. Finally, the dog is reinforced only when its nose is placed at or in the opening of either jar. The entire shaping process can be accomplished in about 10 minutes.

The trainer must be aware that if the reinforcer GOOD does not appear precisely at the moment of the desired response, then the training time will be lengthened considerably. Some responses appear only for a fraction of a second; others linger for longer periods. Consider the first response approximation. If the trainer is attempting to reinforce a downward movement of the head toward a jar but is slow in reinforcing, he may instead inadvertently reinforce head movement away from the jar. In this case the trainer must be sure that the head is still in its downward movement when he reinforces with the word GOOD. Sometimes the animal's head will rise before the reinforcer can be delivered. The trainer then waits until the animal again emits the proper behavior. Occasional errors in timing do not significantly affect the outcome.

(2) Eliminating unwanted behavior during the work session. Should the dog cease its initial random exploratory behavior, or later its more purposeful behavior and sit or lie down during the training session, the trainer immediately lifts the dog back to the standing position with hand pressure made upward on the dog's abdomen. The dog will usually stand up quickly as an escape reaction to the pressure and should immediately continue in its work. The trainer gives no commands, shows no annoyance, and makes no motions that might distract the animal more than momentarily.

(3) Duration and termination of training session. Training in this task terminates after about 60 reinforcements are made on any day. This number can be divided between two sessions if desired. The trainer should not be surprised if some sessions are completed in 2 or 3 minutes. This will happen when the rate of correct responses becomes very high -- reinforcement may then occur as frequently as every two or three seconds.

The session can end in either of two ways: (a) If the dog has satisfactorily completed the designated work, it is briefly petted and praised after delivery of the last food pellet. The animal is then chained at the place of stake-out, given two pellets of food and another few seconds of petting and praise. (b) If the dog has performed poorly, it is returned to the stake-out on a short leash and chained there without being given any reinforcement. The trainer should not show annoyance or anger with the animal or physically harass it in any way at this or any other time.

b. Conditioning acetic acid odor. Through conditioning, the odor of acetic acid becomes a reinforcer. Earlier, the word GOOD became a reinforcer through the procedure of pairing it with food a number of times. The same pairing procedure will be used here, but the pairing now will be done between the acid and the word GOOD, presently a powerful reinforcer as a result of previous conditioning. The role of a reinforcer is to increase the frequency of the behavior which precedes it. Acetic

acid will be used specifically to shape search performance and to help maintain it. Conditioning of other odors later, such as heroin, will perform the same search-reinforcing function. The strength of conditioned reinforcers is maintained by having them followed by food in some of the performance chains.

Because of the nature of the odor stimulus, the trainer will not know at precisely what moment the dog perceives the odor of acetic acid emanating from a jar. In order, therefore, to pair the odor of acetic acid with the reinforcer GOOD, the pairing occurs when the dog's nose is at the odor source, i.e., at or in the mouth of a positive jar (containing acetic acid). Simultaneously with pairing of the stimulus acid odor with GOOD, the reinforcer GOOD is maintaining control of the behavior, "nose at jar opening."

(1) Procedure. The two-jar setting is continued. One jar contains one ounce of a solution of 1 part glacial acetic acid and 1,000 parts tap water and is designated the positive jar. The other jar contains only tap water and is designated the negative jar. Neither jar is covered. The jars are alternated in position in the stimulus board after about every fifth reinforcement.

When the dog brings its nose to or into the mouth of the positive jar for one second, the animal is reinforced with the word GOOD, which is followed with one pellet of food. A response to the negative jar is never reinforced.

A training session can end in either of two ways: (a) When the dog has performed satisfactorily and has received about 40 reinforcements, it is briefly petted and praised after delivery of the last food pellet. The dog is then removed to the stake-out area, chained, given 2 pellets of food and praised again for a few seconds. (b) When a dog does not perform satisfactorily, the session can be terminated at any time. The dog is given an immediate NO and removed on a short leash from the work setting and staked out. The trainer never inflicts physical punishment for poor performance. Two sessions of about 40 reinforcements each are conducted during a work day.

(2) Discrimination performance. At the end of this training step, we can only assume that odor conditioning has occurred. At this point the dog does not yet show any behavior that indicates that the desired conditioning has in fact occurred. Learning an indicator response will be accomplished later.

When undesirable variations appear in the way the dog orients its nose to a positive jar, the only correction needed is to withhold reinforcement until the performance is made precisely as required. Licking the jar is a frequently observed behavior. This can be eliminated by not reinforcing the dog when the tongue is touching the jar. The trainer can also withhold the reinforcer whenever the dog's mouth is open.

Since the dog works off-leash, and is permitted complete freedom in the session, an animal may occasionally wander away from the work setting. During any such excursions, the trainer will merely wait for the animal to return and begin performing again. The interruption usually lasts no longer than one minute. Repeated excursions are indicative of low drive level (motivation). The session is then terminated as prescribed for unsatisfactory performance.

c. Obtaining a nose positioning response at the holes in a jar lid. Two small changes are made in the stimulus objects used in the previous two steps. The jars now are covered with lids. The reason that the training did not begin with the jar-lid configuration is that the odor conditioning of the last step is done more easily without the lid. A change is also made in the strength of the odor.

(1) Procedure. One hole or a cluster of holes, 1/4 inch to 3/8 inch in diameter, should be made, preferably in the center of the lids. In this way, the trainer can easily tell if the nose is in direct opposition to the holes.

Any one pair of jars should not be used for more than five reinforcements before being replaced with a new pair. The right-left positions of jars are reversed on the average after every other reinforcement. About 30 reinforcements now are made in a session. Two sessions can be conducted on any work day.

Reinforcement is made only when the nose is held over the lid holes of the positive jar. Reinforcement should be withheld whenever the animal licks the jar cover.

The odor strength to be used in this training step is reduced by one order of magnitude to one part glacial acetic acid and ten thousand parts tap water.

(2) Discrimination performance. In the initial encounter with jar covers at this stage of training, the animal may spend its time examining all portions of the lids. The time during which the desired behavior occurs may be very brief. The trainer will have to be quick to deliver the word GOOD at the exact moment that the correct behavior appears.

With the concentration of acetic acid used at this stage of training, the animal may not have to come very close to the jar to smell the acetic acid contained therein. It is essential, however, to establish and maintain the nose-on-jar-top behavior in anticipation of the time when very weak odors will be presented. The actions taken here will lessen the possibility that undesirable competing habits will become established, and thus save time later on when unwanted behaviors would have to be extinguished. The trainer should experience little difficulty

in accomplishing the work to this step. The task is a relatively simple one for a dog. Consequences given an animal in previous training for stopping work because of low drive level are also applicable here. Training sessions are terminated as before, depending on whether the dog performs satisfactorily.

d. Obtaining a detection indicator response. The behavior to be obtained in this step will give a clear indication that the animal has in fact detected the presence of the positive stimulus at one of the two jar positions. The animal will learn to hold its nose to the top of the positive jar for as long as 4 seconds.

(1) Procedure. The positive jar contains the same strength solution of acetic acid as that used in the last step, 1 part acetic acid and 10,000 parts water. The negative jar contains only water. The positive and negative jars appear equally often at the right and left positions. The jars are changed in position after every second reinforcement. A given pair of jars is used for only one reinforcement. Before being used again, each jar is thoroughly washed. Twenty-four to thirty-six reinforcements constitute one session. The animal must hold its nose to the top of the positive jar for 1, 2, 3, or 4 seconds before it receives reinforcement. The trainer arbitrarily decides while he is changing jars between reinforcements whether he will require the dog to hold its nose to the jar top for 1, 2, 3, or 4 seconds to be reinforced. However, if the animal inspects the negative jar before moving to the positive one, the dog must then be required to hold its nose to the positive jar for the maximum time of 4 seconds before reinforcement is made. The same terminating procedures used before are applicable here.

(2) Discussion. The discrimination which the animal has to make is an easy one. When the dog inspects the negative jar, it will not remain at it, but will switch immediately to the positive side. When the programmed duration for the positive jar response is 3 to 4 seconds, the animal may raise its head from the positive jar after about one second in anticipation of receiving reinforcement, then return it to the same jar. In the early part of this training step, the trainer may cumulate the time the dog spends in the correct attitude between interruptions and reinforce when the total reaches the programmed duration.

A spurious kind of behavior may sometimes be built up accidentally. In the conditioning process, the response to the positive jar is not the sole element which can come under control of the reinforcement. To some animals, going to the negative jar may become part of the total behavior required for reinforcement. The behavior chain that is built up may include going from the negative jar to the positive one. This spurious behavior, which may occur with increasing frequency as training progresses, is built into the chain that ultimately ends with reinforcement. It is essential that the trainer recognize spurious behaviors

such as this and that he be able to analyze their cause. In this case the behavior chaining may arise when the behavior at the positive jar is not immediately reinforced, possibly because the animal's nose may not be held precisely over the lid openings. This delay in reinforcement can then elicit a movement to the negative jar and a quick switch back to the positive one with immediate reinforcement. The behavior chain can be broken by never immediately reinforcing the correct response at the positive jar if this was immediately preceded by inspection of the negative jar. Whenever the animal inspects the negative jar before going to the positive one, the nose must be held in the proper manner on the positive jar for 4 seconds before reinforcement is made.

Excellent performance sometimes shown by a dog on a difficult discrimination problem may be attributed to the presence of the programmed discriminable stimulus, when actually the animal may be responding to some other more easily discriminable stimulus whose presence consistently parallels the programmed one. This situation can arise when the training setting is not fully controlled against the possibility of having the stimulus of interest paired consistently with other stimulus events. For example, a dog that spends some time orienting on a jar may be marking it differentially with its own respiratory effluvia or saliva, which it subsequently utilizes as a basis for discrimination.

The trainer can easily test whether the jars have been differentially marked by an animal. For this test, he takes two jars which are alike in every respect and arbitrarily assigns one as positive and one as negative. He reinforces on the basis of this assignment. If the animal continues to respond to the same jar after it receives the first reinforcement, then it is highly likely that the animal is marking this jar in some way. However, the animal cannot mark the jar before the first reinforcement is given -- the first reinforcement tells the animal which jar is correct. Because such animal-produced cues may arise during the present and later tests, no jars are used for more than one reinforcement.

The performance criterion for moving on to the next step and to lower odor concentrations is obtaining very sharp performance at this easily discriminable odor level.

e. Improving the detection capability of weak odors. This training is intended to make the animal attend more strongly to the stimulus field. This is done by gradually making it more difficult for the dog to detect the odor stimulus.

(1) Procedure. Training begins with a solution of 1 part acetic acid in 100,000 parts water. Work at this level is continued until the dog makes a correct discrimination with each new pair of jars and the behavior profile remains essentially the same from one paired

presentation to another. Data is collected on Form A of Appendix A. Then the solution strength is decreased by one order of magnitude to 1 part acetic acid to 1,000,000 parts water. For an animal with a good nose, breakdown in discrimination will occur at 1:10,000,000 or 1:100,000,000. If an animal quits at any level before a judgment can be made with confidence regarding its olfactory sensitivity, the trainer increases the solution strength until he obtains good work performance again before returning to a lower concentration. Testing is conducted at the lower concentration until the performance stabilizes to that of the next higher concentration. The trainer continues to decrease the concentration of acetic acid until a concentration is reached to which the dog consistently fails to respond. The trainer stays at each odor concentration for at least one day. After a threshold concentration has been identified, the test procedure is varied as follows (use data sheet of Appendix B):

In a single test session the dog is exposed to eight repetitions of a series of descending odor concentrations that begins 2 orders of magnitude above threshold. Thus, if the threshold is 1 part acetic acid to 10,000,000 parts water, the starting concentration should be 1:100,000.

For one descending series then,one pair of jars is always followed by another pair which is one order of magnitude lower in odor concentration. Usually, four odor concentrations are used in a series. Two are above the animal's threshold, one is at or near it, and one is below its threshold.

Training should not be continued at or near the animal's threshold for longer than one session. When the task is difficult, particularly if the dog has had but limited discrimination test experience, the animal may quit working. If the animal quits near threshold, it is removed from the test setting to the stake-out area. In the next session the task is made easier for the dog.

When the odor is below the animal's threshold of detection, it spends as much time on the negative jar as on the positive. It will often then alternate between both jars several times before choosing one of them at random.

If the dog keeps its nose on the negative jar, one of two consequences occur: (a) Most often, the animal loses its chance for obtaining reinforcement for that particular presentation. Testing is continued with a new pair of jars. (b) Occasionally, it is given a NO and removed from the training session, thus losing its chance to work for food in that session.

A change is made to a new set of jars after each reinforcement. The positions of positive and negative jars are randomized from one paired presentation to the next.

f. Conditioning the animal to heroin odor. The first odor an animal is trained to detect may not be the odor of ultimate interest. The first odor chosen should be easily discriminable and easy to vary in strength to levels at which the dog can no longer detect it. In the present case, acetic acid odor is utilized to obtain search behavior and sensitive detection performance.

Acetic acid was chosen for the initial conditioning of this task for a number of reasons. It has a definite, characteristic odor. It is a common substance and easily obtained. It is soluble in water and is easily and accurately made up in any desired concentration with water. Acetic anhydride is used in the conversion of morphine to heroin.

(1) Transfer to heroin. A fading technique is used to condition the animal to heroin. The principle of the technique is to pair the new substance with one which already elicits a detection response. Then the latter is gradually faded out until the detection response is being made to the new substance alone. The method of rapid descent described in the previous section will be used in the present training. Conduct eight repetitions of a descending series of presentations. In these presentations only the concentration of acetic acid in the positive jar will be varied; the amount of heroin remains the same throughout. The entire procedure is described below.

(2) Procedure. Prepare the heroin stimulus as follows: Distribute about 50 milligrams of heroin on a 3 inch square piece of filter paper. Lightly fold the paper and insert it into a three or four inch long test tube. Place the open tube into a test jar that is positive for acetic acid, i.e., contains one ounce of a solution of acetic acid of starting concentration. Prepare a negative jar to pair with the positive one by inserting a folded piece of filter paper without heroin, into a test tube and then placing the tube in a jar containing one ounce of water. The negative jar thus contains only water, test tube and filter paper. A positive jar is always paired with a negative one in any presentation to the animal. Whenever the test tubes are left outside the jars, they should be sealed with clean cork stoppers. The exterior of the test tubes should be rinsed with water after each use. Since the heroin samples can become contaminated, they should be exchanged for new ones periodically.

Each descending series begins with an acetic acid concentration in the positive jar, two orders of magnitude above threshold. When the acetic acid concentration is reduced below the animal's threshold, then as far as the dog is concerned, there is effectively no acetic acid in the positive jar. It, therefore, is correct to say that at this point the positive and negative jars differ only in the presence of heroin in the positive jar. If the dog responds to the positive jar at a greater-than-chance level, it can be assumed that it is because of the heroin -- provided the trainer has meticulously eliminated all other sources of differentiating cues from the test situation.

It is essential to observe the following basic precautions: Acetic acid solutions are never used more than once in any stage of this training. Positive and negative jars are always treated alike and are distinguishable only in that positive jars contain heroin and acetic acid. No other cue should be permitted to characterize in any systematic way the jars one from another.

g. Detecting heroin in a complex odor field. In this step of training extraneous odors will be deliberately introduced in controlled amounts into the test protocol to give the animal the experience of detecting the positive odorant in a complex odor field. It must be realized, of course, that the test field throughout any of the steps of discrimination training is never devoid of a multiple odor surrounding. Even "clean" jars before use may contain odors smellable by a dog. If irrelevant strong odors appear in a test field, they should be eliminated. Other odors should be controlled so that they accompany positive and negative jars with equal frequency. In this way no systematic difference is accidentally associated with either jar. The animal will then learn not to respond to randomly appearing odors in the sample field.

Heroin found in the illicit market often contains impurities from its manufacture, products of its decomposition, and substances used to "cut" it. Except in controlled tests, the trainer cannot determine what odor or odors any dog is detecting when it responds to the substance called heroin. Since these substances are closely connected with heroin in the search field, and can aid in its detection, they are not used in the present training as background odors, i.e., they are never placed in negative jars. Other odors that are common to the search field but are not systematically associated with heroin will be used as background for heroin in the present training. Examples of background materials are: plastic bags, newspaper, wrapping paper, glue, tape, clothing, food, flowers, earth, wood, spices, leather, etc.

(1) Procedure. A fading technique is used. Heroin of constant strength is combined with a background material of increasingly stronger odor. The effect is a gradual masking of the heroin. The method of rapid descent, the procedure used in previous learning, is also used to present background odors of varying strengths.

At first the animal gets the chance to experience the smell of heroin combined with a weak background odor in several paired presentations. This pretest is made with every background material used. Then the trainer probes for the masking threshold with varying strengths of background material. When he obtains the first threshold approximation, he prepares the sample jars as for use in the method of rapid descent. For the first two trials in the descending series, the background odor strength should be low enough so that the animal can still smell the heroin. On

the third trial, it should be strong enough so that some errors of discrimination are made. On the fourth trial, the background material should completely mask the heroin. The descending series is repeated eight times. The background odor strengths used in the method of rapid descent cannot always be selected with such accuracy that the desired results are always obtained. Sometimes none of the four prepared strengths mask the heroin completely. Positive and negative jars, which constitute a pair, are alike in every respect except for heroin, which is also present in the positive jar. Training sessions are continued with a background material until stability of performance is achieved. Training is conducted with other background materials in the same manner. Following work with single odor backgrounds, further training can be continued with a series of multiple background odors.

h. Acquisition of new odors and elimination of old ones. Although it seems desirable from the operational point of view for a detector dog to be trained to detect more than one substance, there are very good reasons for limiting a heroin-detector dog to the detection of heroin only. Scientific information is not available to tell us how the response of a dog to one substance may be affected when it is trained to respond to a second substance, particularly if the second substance differs greatly in its odor properties from the first. Thus, in the absence of precisely controlled experiments to show what may happen, it is advised that the heroin-detector dog not be trained to detect marijuana. These two substances differ greatly in their odor properties. Pure heroin has almost no odor, and a dog must exert intensive effort to find it. Marijuana, on the other hand, has a distinctive odor, and presents a relatively easy challenge to a dog. Heroin also may occur less frequently than marijuana in operational situations. Under these conditions the dog may give up searching for heroin in favor of the more readily detectable marijuana, and this may easily happen without the handler being aware of it.

The first substance conditioned by the method described here must have a moderate to strong odor. It may be a substance that is itself a target material toward which the training is directed. For example, an explosives detector dog might initially be trained to respond to nitroglycerin dynamite, which has a moderately strong odor. If the target material is known to have very little odor, as is the case with heroin, then the initial training substance must be some material having a distinct odor other than heroin.

The conditioning of any substance with a weak odor begins with the fading technique and continues through the procedures given in Section g. above. The new weak odor is paired with another stronger odor which the animal is already discriminating. The fading is continued until the animal begins to respond to the new odor alone.

The newly conditioned odor is then presented in mixtures with other odors for analysis by the dog. The conditioning of any strong odors by this method begins at Section e., skips Section f., and resumes at Section g. above.

An odor is eliminated as a discriminative stimulus as easily as it is acquired. It is simply removed through extinction. That is, reinforcement is withheld whenever the detection response is made in its presence. The operational procedure for eliminating an odor is to place it in the negative jar during discrimination training of another odor.

The reprogramming of an experienced detector dog for a new odor can be accomplished in about 10 days.

i. Adapting to extraneous stimuli in the search field. The dog's intense concentration on a search task can often be broken by some irrelevant stimulus in its work field. The most common distractions to the dog are people, animals, and food. One way to control against the tendency for extraneous stimuli to obtain the animal's attention is to adapt the dog to them during work sessions until their presence is finally ignored. Adaptation is accomplished by gradually fading potentially distracting stimuli, one at a time, into the animal's work field.

Adaptation to humans must be continuous. The first person to whom the dog quickly adapts is its trainer. The dog learns to ignore the trainer's presence except when he is required to provide the occasion for any subsequent behavior which the animal must make. The next person to whom the dog adapts is the trainer's assistant. The assistant is unimportant for the learning of task behaviors, so he may do almost anything he wishes during the session except make rapid sudden movements or attend to the dog in any way. The next adaptation is made to strangers. They can be faded into the work field until finally the animal will work around strange people in its work field. Investigatory behavior to humans has no consequence. The trainer waits for the dog to resume its task work on its own. If the people in the training environment completely ignore the animal, it will attend progressively less to them.

If a dog is used as a distractor, it should have a friendly and docile nature. It should be a dog which has not been trained in the task behaviors, otherwise it might respond to task stimuli as the trainee animal does. The distractor dog may do as it pleases in the work field and is ignored by the persons present. The trainee dog is at first permitted to respond momentarily to the other dog, but must not begin any playful activity. If the distraction is for more than five seconds or playful behavior is engaged in, the trainer says NO...COME and returns the dog to task activity. If the animal does not respond to recall, the trainer says NO and removes the dog from training for

a period of time. As adaptation continues, a time-out from work will be given for increasingly smaller interruptions in correct behaviors, resulting from distracting stimuli.

If a cat serves as a distractor stimulus, it should be one that is accustomed to dogs and behaves quietly. The trainer assistant may place the cat in his lap and stroke it while sitting in the work area. Any unusual interest shown by the dog toward the cat should bring on the correction procedure.

Food is often found in a real search field. The dog's interest in food odors may seriously interfere with its response to the task stimulus odor. The dog must be adapted to working in the presence of distracting food odors. Training may begin with food in a wrapper or bag. Any interest shown in this stimulus is immediately corrected with NO and the command COME is given. Continued interest brings on the reinforcer NO and a time-out from the food-working situation. With further training, food can be left completely exposed in some sessions.

IV. SEARCH TRAINING

A. SIMPLE SEARCH.

Search chain training establishes good control over those locomotor behaviors which are used to conduct a search task. With this control, the trainer can repeatedly get the animal to a place where food is found. Discrimination training teaches the animal to recognize the object of search. A simple search model becomes complete when these two performances are combined along with the additional behaviors, SIT, STAY, and COME.

Figures 8, 9, 10 and 11 show a dog in simple search. The behavior sequence in the task is movement to HEEL, movement from HEEL, olfactory examination of objects, and sitting at the correct object. The sequence is repeated following food reinforcement. The stimulus board described in Section III.E. is also used here.

1. Procedure.

In this training, search chain behaviors continue to be refined. The components of simple search are put together in the following steps:

a. The setting approximates that found in odor discrimination training. The stimulus board is used to hold two one-quart test jars (Mason jars). The negative jar contains one ounce of water; the positive one contains one ounce of 1:100,000 solution of acetic acid. The same pair of jars can be used for about 6 trials before it is replaced with another pair. The trainer releases the dog about 6 feet from the stimulus board. The animal will probably go immediately to the jars and begin smelling them. When the dog's nose is at the positive jar, GOOD is sounded and the trainer reaches over from behind the animal to deliver the food pellet. Following reinforcement, the dog is led to a point about 6 feet away and released. The same procedure is repeated until the animal smoothly executes the task. The trainer switches jar positions randomly between presentations. Three to six trials may be sufficient.

b. When the animal sniffs the correct jar for one second, the trainer commands the dog to sit. Otherwise the procedures are the same as above. The trainer gives both the touch and voice signals in a paired sequence, i.e., the verbal SIT precedes light touch on rump by 1/2 second. After about six trials, only the verbal SIT is continued. The command SIT is delivered in a soft tone. The reinforcer GOOD is given at the moment when the dog's rump touches the floor. Occasionally, the trainer will test for sit response learning by delaying giving the SIT

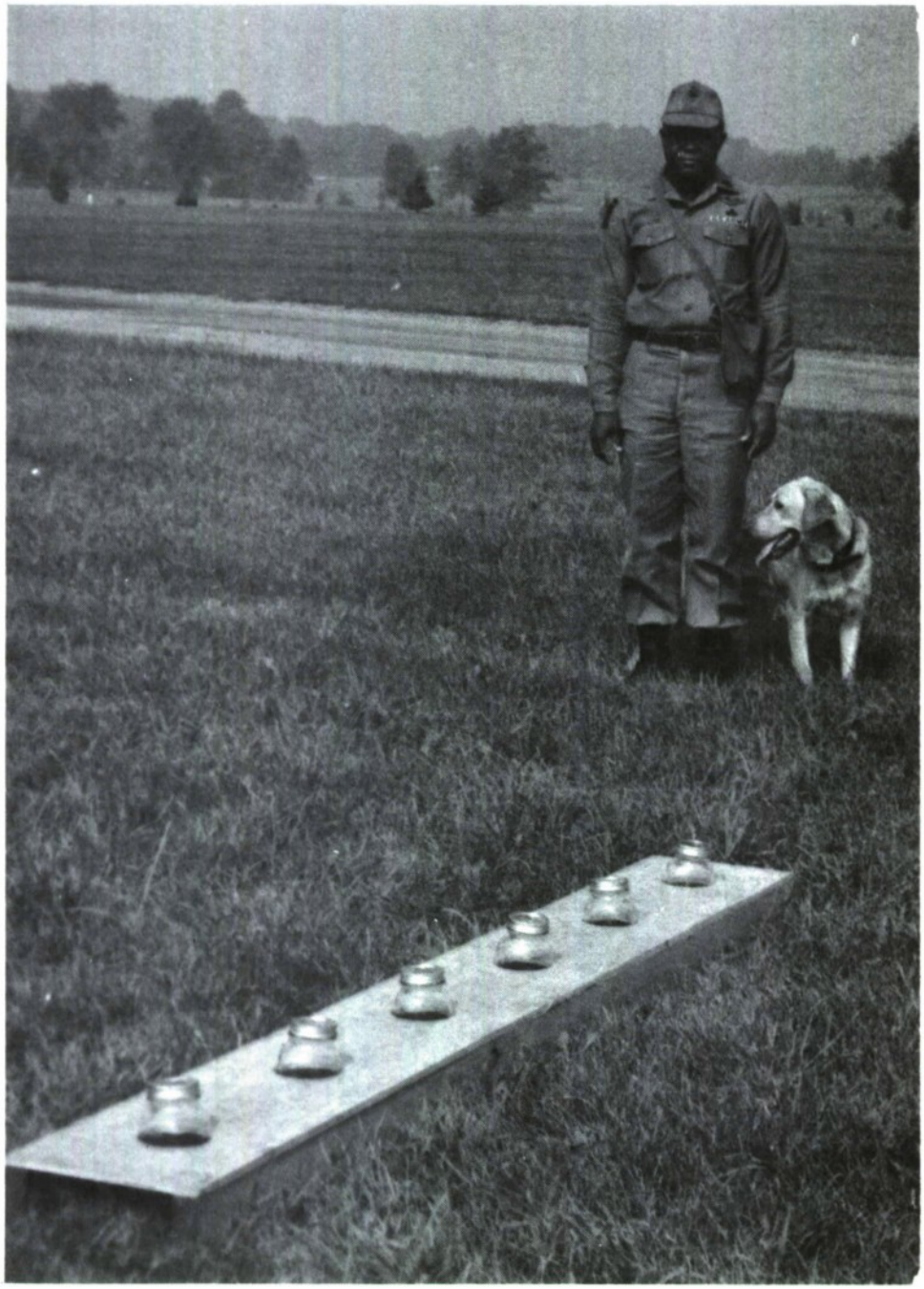

FIGURE 8. Simple Search: Preparing to Move Out from HEEL.

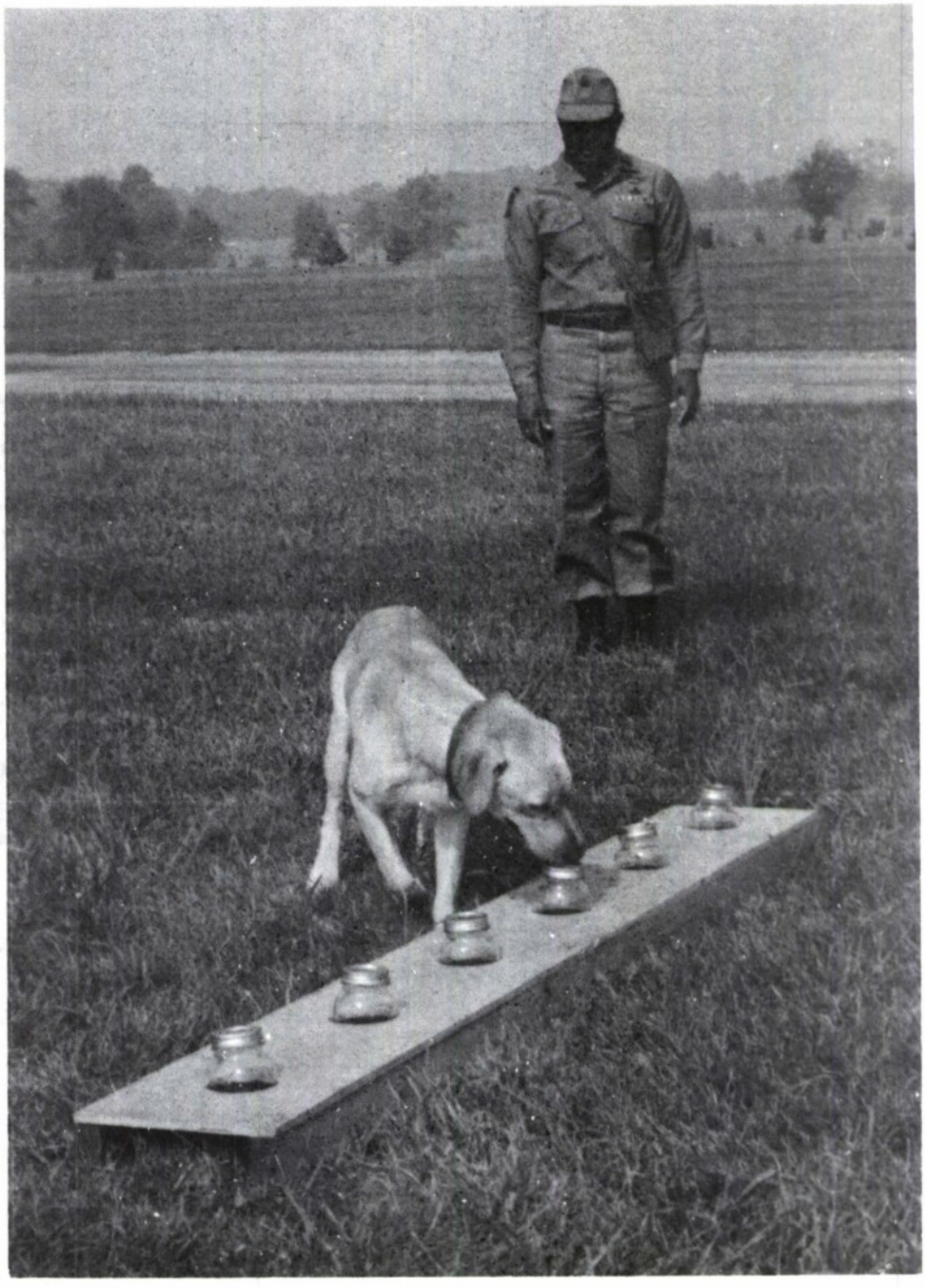

FIGURE 9. Simple Search: Sampling the Odor Field.

FIGURE 10. Simple Search: Detection Response.

FIGURE 11. Simple Search: Reinforcement.

command. As the SIT command continues to be given each time the dog sniffs for one second at the correct jar, the animal will soon anticipate the command and spontaneously sit at those times when the command is delayed. The procedures of this step are continued until the dog is frequently making a voluntary sit correctly at the positive jar.

c. The search chain is introduced. The trainer positions himself at the point from which he had been releasing the animal on former trials. This time he commands the dog to COME. Upon coming to the trainer and assuming the HEEL position, the dog must remain at HEEL until the trainer gives a light push forward on its collar. The dog then moves to the jars and does the same things that it did in the previous step. After the trainer delivers the food pellet, he moves back again to the starting point and repeats the sequence. As trials are repeated, two test jars are randomly placed in any of the six holes of the stimulus board.

d. Six jars are now introduced into the test situation. Only one jar is positive. Every hole in the stimulus board is occupied. Hole positions for all jars are randomized after each reinforcement. The trainer assumes his usual position and starts the search sequence as before. Now, however, the dog is allowed to return to HEEL whenever it feels like doing so. It is then sent out again. If the dog stops anywhere at the stimulus board but does not sniff the jars, it is recalled for another search try. If the dog continues to work poorly, it is simply removed from the test situation and staked out for a period of time.

B. CHANGE TO INTERMITTENT FOOD REINFORCEMENT SCHEDULE.

During the acquisition of task behaviors, the dog is given a pellet of food every time it performs correctly. This schedule of food delivery is called continuous reinforcement. After a high performance level of a required behavior, simple search, for instance, has been attained, reinforcement need not be given for each correct performance of the behavior. An "intermittent" schedule of reinforcement can now be introduced.

For the first ten days on the new intermittent reinforcement schedule, the dog is given food for correct performance of the required behaviors 50 percent of the time. The other 50 percent of the time the correct performance is reinforced with light petting. For the next five days, the schedule is changed to 25 percent food and 75 percent petting. Then for five days, the schedule is 10 percent food and 90 percent petting. Finally, the dog is given no food for the duration of the work session. The trainer has the option of giving the dog a few pellets of food at the end of a session for which goal food is not scheduled. The goal food is given at the end of the last work session of the day according to procedures described earlier.

C. SPECIALIZED SEARCH.

In this section training is described for 4 search scenarios. Other scenarios can be incorporated in the training as required. However, search success will be greatly enhanced in any scenario by skillful managing of the working dog by its handler. If the scenario is a familiar one, the dog will require little assistance in conducting the search and the handler can stay behind the dog. In novel surroundings, the dog works at the left side of the handler. The handler thus can narrow the search field and increase the speed of search. He can point to places which he wishes the dog to examine closely. Search speed will then depend on the rate at which the handler moves to his right.

The dog can be worked in limited operations after it has completed training in container search. At the same time training can continue in the other modes of search activity.

1. Container Search.

The procedure for conducting container search is similar to that of simple search (see Section IV.A.). Containers or packages of various kinds replace the Mason jars in the search field. Examples of containers to be used in training are -- mail parcels, paper bags, attache cases, valises, suitcases, briefcases, pill boxes, crates, tea pots, flower vases, fruit baskets, canisters, purses, satchels, hand bags, sacks, tobacco pouches, etc. The dog obtains experience with odors of various containers in work described in Section III.E.2.g.

a. Procedure. All stimulus objects used in the first stage of this training are parcels which look alike and are about 1/2 cubic foot in volume. Heroin covered filter papers, such as those used in odor discrimination training, are attached to the sides of parcels with transparent tape along the edges. These parcels are designated positive. Non-heroin containing filter papers are affixed in the same manner to other parcels that then are designated negative. Contamination of negative objects with the heroin powder must be avoided. All parcels are then wrapped with at least one layer of brown wrapping paper. After wrapping, each positive parcel, i.e., each parcel that contains heroin, is inconspicuously marked with pencil to identify it to the trainer. Individual parcels may be reused, but the outer wrapping should be changed frequently. As training progresses, the thickness and nature of wrapping can be increased; for example, boxes can be wrapped in polyethylene film plus wrapping paper and the wrapped assembly can be placed within wooden and/or metal outer containers.

The animal learns to examine objects of different shapes and configurations as it did the Mason jars in Section III.E. For shaping the response, "Sniffing Parcel," the positive object may contain acetic acid odor. For this purpose cotton in a test tube is wetted with a solution of 1 part acetic acid in 1,000 parts of water and is enclosed within the parcel.

The animal makes a transition to parcel search by means of the procedures used to develop simple search (see Section IV.A.). That is, the animal first approaches two parcels placed on the floor about 6 feet away. More parcels are subsequently added. The number of objects in the search field can vary from one session to another, but usually only one of the total number present is positive. Package characteristics are then gradually modified until they vary significantly one from another. Care must be taken that the positive package does not vary systematically in a way that will provide the animal with a cue, in addition to the heroin odor, as a basis for making a discrimination.

The trainer has the option of remaining at the starting position or moving along with the dog as it inspects each package in turn. If the trainer accompanies the dog, then he can point to specific packages for the animal to examine more closely. For the purpose of pointing, the handler carries a "swagger stick." This stick should never be used to touch the animal or to threaten it.

When the pointing procedure is first begun, every package pointed to is positive. In the next series of trials, the first or the second package pointed to is the correct one. Subsequently, positive and negative packages are indicated at random until every package in the field has an equal chance of being indicated. As the trainer points, he says CHECK THIS OUT. The pointing procedure should be used sparingly, otherwise the animal may become dependent on it.

2. Room and Building Search.

a. Procedure. In container search training, the search objects are arranged in a line. Room search training begins with the same linear arrangement of parcels along the walls. The animal will work close to the walls and move from left to right as it faces a wall. The trainer remains at the right rear of the animal and moves along with it. He can slow the animal's search speed by getting in the way of its direction of movement. The dog's search speed can be speeded up by the trainer pointing to the place further along the direction of search and saying CHECK THIS OUT. As trials progress, the parcels are gradually spaced at increasingly greater distances from one another along the walls. If the dog cuts across a room instead of working systematically along the walls, it is recalled to the place it left and started in search again.

The next step in this training is to place parcels on chairs or desks or tables within reach of the dog's nose. The same basic pattern and direction of search in the room is maintained, i.e., from left to right. The dog should be encouraged to leap on furniture to examine parcels placed on it. The dog thus learns to examine the furniture in a room. It always searches in a counterclockwise direction around individual items of furniture. At first, the search objects are found exposed on the furniture or in open drawers; as training progresses, the parcels gradually are hidden from view.

For the next training step, the samples are completely hidden in drawers, behind books, under the furniture, etc. Since the animal no longer can see the objects, they are changed to a more convenient form. For the positive sample about 50 milligrams of heroin is carefully placed in a test tube marked plus (+). A plug of absorbent cotton is placed in the neck of the test tube. When the test tube is not in use in the search field, it is stoppered with a clean cork. Similar test tubes are prepared without the heroin, but have the cotton plug and a cork stopper when the tube is not in use. These are marked minus (-). The dog must learn to smell the heroin odor through the cracks of drawers and doors. In early trials, several positive tubes or several negative tubes may be placed in the same space. Containers of various kinds continue to be exposed in the room search field.

The word NO is seldom used in room and building search. If an animal leaves the immediate search area, it is recalled. The NO is given following a period of poor performance and the dog is removed from the search field for a period of time.

b. Notes on building search.

(1) Since the handler's attention is fully taken up by the dog and the immediate area of search, overall search direction should be done by some other person.

(2) The animal cannot be expected to detect heroin in places that are not accessible to its nose, e.g., the ceiling of a room.

(3) A well-trained dog can conduct a detailed search of 3,000 square feet of office space in about 30 minutes.

(4) As experience in room and building search is acquired, the duration of a training session is gradually increased from 10 minutes to 30 minutes or longer.

(5) A sample showing how data can be recorded during room and building training is in Appendix C.

(6) The odor from the positive sample will linger in closed spaces, such as drawers and cabinets, for some period of time after the sample has been removed. These places should be aired a few hours before the field is programmed for another dog.

(7) The same programmed field should not be used for more than one dog. As a dog searches an area, it may leave cues that another dog will pick up if it is run through the same area.

3. Vehicle Search.

The same kind of parcels which were used in container search training are now placed in and/or on different parts of vehicles, such as passenger cars, trucks, buses, aircraft and boats. As training progresses, the parcels are faded out of sight. Again, as in room search, the dog's direction of search is always from left to right. The dog is made to climb inside the vehicles to search the interior, where it examines the seats, floor space, doors, under the dashboard, etc. The dog should be given experience in searching truck cargoes.

4. Searching Persons.

Training the dog to search people is conducted with pairs of small packages, each pair consisting of a positive and a negative package. The packages are about the size of a pack of cigarettes. Positive and negative packages are prepared as for container search (Section IV.C.1.). Initially, one positive and one negative package are placed on the floor about 6 feet apart close to a wall. A 6-foot length of string is attached to each package at one end. The other end of each string is attached to the wall at a height about 6 feet directly above each package. As trials continue, the packages are raised progressively higher by the strings, until they are suspended 3 feet above the floor on the wall. Simultaneously, a trainer's assistant gradually approaches each of the two packages, beginning from a position about 4 feet away and next to the wall, until he finally comes in contact with the package. Then, on successive trials, the packages are held by the string against different parts of the person. Next, the packages are faded out of sight into the pockets and between the legs. Finally, two or more persons, with positive and/or negative packages secreted on them, are positioned in a line at a distance from the wall. The dog searches each person in turn. For this training to be effective, each person must have available fresh clothing for a complete change after each use. Training sessions are about 10 minutes in duration.

V. MAINTAINING PERFORMANCE

Maintenance testing continues for as long as the dog is kept in an operational status. The maintenance work accomplishes three main functions: (1) It reveals changes in the dog's interest in the task. (2) It shows any alterations to the animal's sensory sensitivity. (3) It trains the animal to search new surroundings and new variations in the make-up of the odor producing substance.

The maintenance schedule includes testing in Odor Discrimination (Section III.E.2.g.), Simple Search (Section IV.A.), and Specialized Search (Section IV.C.). The odor discrimination testing is done with complex background and masking odors. This can be scheduled twice a week. Practice in simple search performance can be carried on with the odor configurations used in odor discrimination maintenance work. This can be scheduled one or more times per week. Specialized search testing is performed two or more times a week. Whenever the dog is not worked on the system tasks, the goal food is given as reinforcement for an easily and quickly obtainable behavior, i.e., a good return following recall.

APPENDIX A

ODOR DISCRIMINATION, 2-POSITION (FORM A)

ANIMAL_____ TRAINER_____ SCORER_____

DATE_____ SESSION_____ CONDITION_____

TRIALS

1._____	16._____	31._____	46._____
2._____	17._____	32._____	47._____
3._____	18._____	33._____	48._____
4._____	19._____	34._____	49._____
5._____	20._____	35._____	50._____
6._____	21._____	36._____	51._____
7._____	22._____	37._____	52._____
8._____	23._____	38._____	53._____
9._____	24._____	39._____	54._____
10._____	25._____	40._____	55._____
11._____	26._____	41._____	56._____
12._____	27._____	42._____	57._____
13._____	28._____	43._____	58._____
14._____	29._____	44._____	59._____
15._____	30._____	45._____	60._____

REMARKS_____

_____

_____

_____

APPENDIX B

ODOR DISCRIMINATION, 2-POSITION (FORM B)

ANIMAL_____ TRAINER_____ SCORER_____

DATE_____ CONDITION_____

SESSION_____ SERIES

Strength of Substance	1	2	3	4	5	6	7	8	9

SESSION_____ SERIES

Strength of Substance	1	2	3	4	5	6	7	8	9

REMARKS_____

APPENDIX C

SPECIALIZED SEARCH - Data Form

ANIMAL_____ TRAINER_____ SCORER_____

DATE_____ SEARCH FIELD_____

CONCEALMENT	RESPONSE	TIME	COMMENTS

GENERAL REMARKS_____

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13. ABSTRACT

The acquisition and maintenance of detection and search task behaviors are accomplished with positive control techniques. The principal controlling reinforcer (consequence) used is food. The dog is permitted to behave freely in the work environment without coercion and with minimal restraint. If a dog, before training, shows timidity, cowering, avoidance and "submissiveness" (orienting on handler) behavior, it undergoes desensitization to the stimuli that elicit these responses. The dogs initially learn the meaning of conditioned reinforcers. The conditioned reinforcers are then used to obtain the fundamental skills, recall, sit, stay, search chain and odor discrimination. The performance of task behaviors is gradually shaped in small steps, beginning with very simple and easily learned behaviors. A simple search model is obtained when these fundamental performances are combined. Training procedures are described in four search scenarios. The validity of the method described was established by obtaining a clear discrimination to heroin and simple search control in two dogs.

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