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TECHNICAL REPORT NO. LWL-CR-08B69

OFF LEASH TRACKER DOG-HELICOPTER
TRACKING TEAM

Final Report
Contract No. DAAD05-69-C-0177

20

By
E. Carr-Harris
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Behavior Systems, Incorporated
Raleigh, North Carolina

September 1969

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Aberdeen Proving Ground, Maryland 21005

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ABSTRACT

The purpose of this study was to explore the feasibility of training tracker dogs to work off-leash in conjunction with a helicopter to locate enemy personnel. The two essential elements of the task were considered to be the ability of the dog to work off-leash, independent of the handler, and the ability of the dog to display stalking behavior. This latter term was defined as the dog vigorously pursuing a target while carefully avoiding alerting target personnel to his presence.

Two Labrador Retrievers were trained to the independent tracking task while two different animals were trained to display the stalking response. Several techniques were tried and discarded with a final set being developed during the fourth month of the contract. The dogs were trained by these procedures for six weeks and their behaviors successfully demonstrated to Limited War Laboratories personnel on June 19-20 and June 25 of this year. For details of the demonstration, see Appendix A.

Although a few problems pertinent to the pretrial effectiveness of the overall dog/helicopter team still need to be worked out, it would appear that the feasibility of training suitable behavior on the part of the dog has been established. It is recommended that the program be extended to resolve the remaining problems and produce a fully functional, complete system.

FOREWORD

The work described in this report was conducted by Behavior Systems Incorporated at Raleigh, North Carolina under Contract DAAD05-69-C-0177. The authors wish to acknowledge the technical assistance of other members of the BSI staff, particularly R. Thal and C. Thal.¹

Appreciation is also extended to members of Limited War Laboratory for their encouragement and advice; in particular Dr. Max Krauss, Mr. Milton Cutler and most of all to Mr. Scott Tomlinson.

In conducting the research described in this report, the investigators adhered to the "Guide for Laboratory Animal Facilities and Care" as promulgated by the Committee on the Guide for Laboratory Animal Resources, National Academy of Sciences--National Research Council.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

¹BSI is also grateful for the assistance of Dr. R. E. Lubow, J. Vance, D. Winkworth and E. Rhew.

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INTRODUCTION

The history of the use of tracker dogs in military and para-military operations is quite ancient and need not concern us here, except as testimonial to the general utility of the tracker dog. Present day usage of the tracker dog in the United States Army, particularly as concerns their tactical deployment, are derived primarily from British experience and doctrine, particularly from their use in Malaya, and the Asiatic sub-continent over the last two and one-half decades. The British experience has been made available to the U. S. through a variety of channels including visits of U. S. Army personnel to the British Malaysian operations (Lt. Col. E. B. Junge, RAC Military Advisor, memo undated) and the use of British personnel to initiate and consult on American efforts; e.g., Captain Hall-Smith working on the tracker dog programs at Fort Gordon, and Major Woods working on the human visual tracker program, also at Fort Gordon. (At this point it should be mentioned that Behavior Systems Incorporated personnel have had frequent contact with both men at Fort Gordon and are becoming increasingly familiar with British technique.)

Typically, the tracker dog is worked as one part of a team that consists of both the dog and a human visual tracker; and, furthermore, the dog is on leash. The human is considered to be the primary element in this man-dog system. It is quite obvious that there are a number of severe limitations to the tactical utility of this mode of operation.

The mission is a fairly dangerous one for the human who is quite vulnerable in this situation. Without fire power support, the mission would be taken up with much reluctance;

with that support, the mission effectiveness is compromised on several counts:

- a. speed of operation
- b. covertness of operation
- c. efficient use of supporting personnel who could be deployed on other tasks

This first point then argues against the use of supporting personnel for the on-leash system, if an equally viable system can be demonstrated.

However, even if one could devise a man-dog on-leash system there are several cogent arguments for entirely removing the man from the man-on-leash-dog system, at least as far as physical proximity.

- a. The off-leash dog can travel faster than the on-leash dog.
- b. The off-leash dog can work for longer periods of time than the on-leash dog.
- c. The off-leash dog can go through terrain that the on-leash dog cannot traverse. All of these points have been repeatedly borne out in our own work with off-leash mine, booby trap, trip wire detecting dogs and off-leash tunnel detecting dogs.
- d. This last point, although fairly obvious, is worth repeating. The off-leash handler is in a safer position than the on-leash handler. And, if the handler is removed entirely from the terrain and put in a helicopter, further safety advantages accrue.

Considering then that dogs are useful tools in tracking, and that their utility perhaps can be increased while at the same time increasing the safety of the humans in the system, the objectives of the program then become both clear and valuable: "to explore the feasibility of training tracker dogs to work off-leash in conjunction with a helicopter to locate enemy personnel."

SCOPE OF WORK

Work on this program began in January 1969 and terminated on July 2, 1969. Its objective was to explore the feasibility of training tracker dogs to work off-leash in conjunction with a helicopter to locate enemy personnel.

In order for the dog to perform satisfactorily in such a system it was considered necessary that it be able to display the following two types of behavior.

1. Follow a human scent trail over various types of terrain without a human handler being present to provide motivation or to assist in solving tracking problems such as backtracks, water crossings, etc.

2. Vigorously pursue and overtake target personnel without alerting them to its presence. That is, if the target has become fixed the animal must assume a freezing position 10-50 meters behind or, in the case of a moving target, assume a 'stalking' attitude by maintaining a 10-50 meter distance behind the target.

The Scope of Work was therefore limited to training four Labrador Retrievers to demonstrate technical feasibility in these two tasks.

Early in the contract it became apparent that much pilot work would be needed to establish functional training procedures for both tasks. In view of the time restrictions involved it was therefore decided to train for the two tasks concurrently rather than sequentially. Two dogs were assigned to work on the independent tracking problem and two on the stalking response. A detailed description of all procedures used has been included in Appendix B.

Work on the independent trackers proceeded rapidly until the latter part of April. At that time the dogs were capable of following a decoy given a 1.75 hour head start and were

successfully coping with such problems as 200 feet of back-track and 100 feet of stream walking. However, the behavior seemed to break down if lead times of greater than 1.75 hours were attempted. Under close examination the problem appeared to be with the limited type of tracking experience we had given the animals up to that point. All training trials had taken place in the relatively densely wooded areas of the training site. As a result the dogs were able to work on residual air-borne scent, ignoring ground scent. Under our local climatic conditions it would appear that this type of olfactory stimulus dissipates in approximately 1-2 hours. The animals were switched to an open site which forced them to use ground scent to track and their training began all over again. By the time they were demonstrated on June 19 and 20, they had been worked back up to 1-1.5 hour tracks that forced the utilization of ground scent for at least 1/3 of the trail. We have no reason to believe that the length of the time delay could not be extended by several hours more. It is our feeling at this time that the final set of procedures should allow us to train other dogs to this specific task within 8-10 weeks.

The development of practical procedures to train the stalking responses proved to be by far the most difficult task. A delicate balance of approach and avoidance behaviors has to be established and maintained in the absence of the handler.

After several false starts, a functional set of procedures was established and instituted by the second week in May. Both dogs responded nicely to these techniques and are presently exhibiting the freezing behavior called for at a fairly high degree of reliability (an average of 13-14 out of 15 times). Again, these procedures should enable us to train future dogs for the freeze response within 8-10 weeks.

It should be emphasized that although procedures have been developed and feasibility demonstrated for each task, we have not had sufficient time to train both responses in the same dog. However, there is no reason to believe that such an integration would present any technical problems.

CONCLUSIONS AND RECOMMENDATIONS

The fact that the feasibility of training dogs to track independently and freeze before approaching a target has been demonstrated, does not in itself insure a successful dog/helicopter team. Perhaps the most essential link in such a system is the necessary exchange of information between ground and air. Either electronically or behaviorally, the dog must convey two kinds of data to the helicopter which, in turn, must be able to adequately interpret such information.

1. The dog's location and general direction of movement must be accurately determined by the helicopter. There is probably no type of behavior that the dog could be trained to that would assist in conveying this kind of information. The system would, therefore, be limited at this point by the availability of adequate electronic DF equipment.

2. The helicopter must know whether the dog is pursuing a still distant target or has made contact and is within stalking distance. This sort of information can be conveyed by the animal's trained behavior, although the desirability of any particular response pattern will still depend on the helicopter's ability to discriminate between the dog's ongoing tracking behavior and the occurrence of the trained stalking response. The data central to the concept of such a trained response is that which relates to the dog's rate of movement. When pursuing a still distant target, the dog moves out rapidly. When following a moving target that he has already caught up with, his rate slows to that of the target. If the target stops, the dog freezes with no forward movement. The most desirable situation would, therefore, be one in which the helicopter was able to get an accurate ongoing measurement of the dog's rate of movement as a continuous variable. This could be accomplished by mounting the movement sensor on the dog's leg.

A less desirable approach would involve the ability of the helicopter to measure the dog's forward motion as a dichotomy i.e., movement vs. freeze. This situation puts a heavy burden on the training of the dog. In the case of a moving target, the animal's natural behavior is to follow at a reduced speed that keeps it out of visual contact by the target. If the dog is required to freeze in order to convey the information that he has caught up with the target, it must also be required to make a decision as to when to get up and continue his pursuit. This sort of elapsed time judgment would be extremely difficult to train. Of course, if the dog has a receiver mounted on his harness, it would be possible to send it a discrete signal to continue, from the helicopter. Whereas this would be more feasible from the animal training point of view, it does place even greater requirements on the hardware needed for the system. Another possibility is for the helicopter to generate an auditory signal that could be heard by the dog on the ground. If tactically desirable this could be a high frequency tone, relatively inaudible to the human ear.

One final problem concerns the desirability of recalling the dog out of danger before countermeasures are initiated against the target personnel. Again, the recognition of an appropriate time to break contact is a tactical judgment that the dog cannot be expected to make. The animal must be given a discrete signal, upon the reception of which it could be trained to either backtrack itself or to break contact and locate the source of the signal. Which method is used should depend on tactical considerations. There would be no technical difficulties in training the response in either case.

SUGGESTIONS FOR FURTHER WORK

In order to achieve a fully functional tracker dog/helicopter team, further work is needed in the following areas:

1. The two behaviors of independent tracking and stalking should be integrated in the same animal. It is desirable that some pilot work be conducted to establish the most efficient procedures for this.
2. Some evaluation of the reliability and limits for the behavior should be made. Trained animals should be tested in such dimensions as age of trail, length of run before first contact, maximum distance from the target at which the stalking response can occur, and maximum duration of the freeze response.
3. Tactical considerations should be evaluated in order to define a suitable recall capability. Pilot work should then be conducted to develop the best training procedures and to investigate the most appropriate time to integrate this test into the overall training program.
4. Certain physiological responses, such as the heart rate and skin temperature of already trained dogs should be monitored while they are performing the tracking and stalking tasks. Such information would be invaluable with regards to increasing training efficiency and evaluating the limits of useful utilization in, not only the off-leash trackers, but in virtually all military dogs.
5. Proposed radio hardware should be tested on dogs performing problems which realistically simulate operational conditions.

APPENDIX A

FINAL DEMONSTRATION

Independent Tracking

Date: June 19-20, 1969

Attending: Those present at the first demonstration were Mr. Cutler, Dr. Krauss, Col. Hastings, and Mr. Tomlinson from Limited War Laboratory; Dr. Maag, at the invitation of BSI; and Dr. Lubow, Mr. Thal, and Miss Carr-Harris from BSI.

Description: June 19 - Independent Tracking. The first was a short complex track. The target was a backtrack, then a stream crossing and finally looped back near where he backtracked. The dog, Kala, was released 15 minutes after the target started. When it reached the backtrack, it picked up the source scent of the target and went directly to him without completing the track. For the second run, the target was observed from the helicopter as he traveled from a point two miles from the BSI Field Station to a field on BSI land. This course included rough open fields, heavily wooded areas, freshly plowed fields, streams and swamps. The dog, Luke, was released one hour after the target left and made contact within half an hour. When the dog was observed crossing open areas, it was obvious that it was following the target's track. For the third run, Kala was again run on a short track. Again, she picked up the source scent of the target before completing the entire track.

Description: June 20 - Independent Tracking. The first part of the day was spent testing the radio equipment since the helicopter was still available.

Luke was run on a 45 minute run in a large field which was situated such that the target and dog could be observed throughout the whole trial. It was amply apparent that Luke was following the ground scent of the target.

Stalking Response

Date: June 25, 1969

Attending: Those present at the second demonstration were Dr. Krauss, and Mr. Tomlinson from Limited War Laboratory, and Mr. Thal and Miss Carr-Harris from BSI.

Description: June 25 - Stalking/tracking. The dog, Nimrod, was run first on a one-mile course through both wooded and open terrain. The target was given a five-minute head start and continued to move along the trail without stopping. This allowed the dog to overtake the target 20 times during the course of the run. Out of 20 trials the dog made 19 good responses, assuming the down position as soon as the target's presence was perceived ahead.

Next, the dog, Babe, was run on a one-mile course through both wooded and open terrain. The target was given a full 20 minutes head start. The dog was required to follow the track without a handler being present, and to make the proper response upon perceiving the presence of the target. Babe successfully completed both the tracking and response requirements.

APPENDIX B

TRAINING PROCEDURES

All dogs received ten days of adaptation to their new environment and prime diet. A schedule of one hour per day of obedience was begun on Day 1 of the contract and continued throughout. The animals progressed from basic obedience through off-leash obedience via training techniques essentially the same as those outlined in FM 20/20.

As soon as tracker training began the dogs were always harnessed during work periods with the harness being removed for transportation or play periods.

Food reinforcement constituted a basic training technique. The animals' individual daily food ration was divided in accordance with the number of trials scheduled for that day. All feedings, except on weekends, took place in the field and were contingent upon correct responding.

Tracking training was begun for all four animals during the second contract week. Initial procedures were largely the same as those used by the Combat Tracker Teams at Ft. Gordon. That is, the animal was taken to a relatively open space where the target moved out about ten feet ahead, turned around and encouraged the dog to approach him. As soon as the animal reaches the target he is fed the assigned portion of daily ration by the target.

The above procedure was continued with steadily increasing track distances. Whenever the distance between the starting point of the dog and the fixed position of the target exceeded 100 yds. or if the target was out of the animal's line of vision at the starting point, an article of the target's clothes was left in the track with food placed on it.

As soon as the animals were performing satisfactorily on 100-200 yd. tracks, the training site was moved to the network of trails in the wooded areas of BSI's field station. After a few days of adaptation to the new site, two dogs were

assigned to the independent tracking task and two to the stalking response task. Training for the two groups proceeded separately from this point on.

STALKING RESPONSE GROUP

The response dogs were run for two weeks on simple tracks that took the target 10-15 minutes to set. The purpose of this series of trials was to familiarize the trainer with any individual, idiosyncratic behavior that the animals might display when crossing from ground scent cues to the airborne scent present when the target was sufficiently close.

When the trainer felt he could accurately distinguish the boundary between ground and source scent, he began placing the dog in a down position at that moment. The target would then run up and feed the dog in order to keep the response firmly tied to the presence of a target. As soon as the animal's behavior indicated that he was sufficiently target oriented, the delivery of reinforcement was phased back. The trainer gradually became the exclusive source of reinforcement.

The above procedures proved inadequate to elicit the needed voluntary down responses. Upon analysis, it was decided that the intertrial interval necessitated by the tracking task was too long to permit learning of the down response. A second set of procedures was, therefore, attempted. The length between trials was reduced to 30 yd. intervals, with the dog being placed in the down position about 20 ft. in front of the target. This technique did produce voluntary responses but of insufficient frequency and reliability.

A study of the problem produced the hypothesis that whereas the decrease in inter-trial intervals had significantly aided in the establishment of a response, the stimulus to elicit it was still undifferentiated by the dog. The original stimulus we attempted to work with (the boundary between ground and source scent) was useless because of the trainer's

sensory incapacity to recognize its presence, and place the animal in the down position as soon as it occurred. The second attempt used a stimulus (arbitrary 20') that involved a distance judgement on the part of the dog. Such time/space judgements are extremely difficult to train without an additional discrete stimulus to demonstrate the boundaries of the dimension involved.

One more attempt was made to train for the desired ground to source scent boundary but with the addition of a significant primary stimulus. Both dogs were trained by means of standard classical conditioning techniques to assume the down position upon hearing a whistle blow. As soon as this response was thoroughly reliable (90%) the animals were put back on the 10-15 minute tracking task, and the trainer instructed to signal the target via his radio when the dogs first picked up the source scent. The target would then blow the whistle which would put the dog in the down position. Again, the technique failed. This was probably due to a combination of the reversion to long inter-trial intervals and the fact that the external signs of awareness of source scent had almost completely extinguished.

The final and functional set of procedures combined the whistle approach with the setting of an arbitrary limit of 20' from the target. The dogs were run for two days of 60 trials per day. Inter-trial intervals were reduced to 1-2 minutes. The trainer would place the dog in a down position 2-3 trials in succession at a distance of 20' from the target. On the next 1-2 runs, the animal would be permitted to approach the target freely until he reached the 20 ft. limit at which point he was 'whistled down'. After 20-30 such trials, voluntary down responses began to appear with steadily increasing frequency. By the beginning of the third day, reinforcement was made contingent upon such voluntary responses. Five more days were spent in stabilizing the behavior and bringing it up to 90% reliability. The dogs were then taken off leash and trained to work at the limits of visual contact with the trainer.

The next step was to drop the discrete trial structure and use a continually moving target. The dogs would pursue, catch up with the target, respond, be reinforced, wait 2 minutes and pursue the target again. The contingencies of reinforcement in such a situation are such as to make it to the dog's advantage to respond as early as possible. They therefore began to work back, increasing the distance between response and target without specific training. At the time of the demonstration they would respond at 50-60 yards behind the target. The response was still largely cued by visual stimuli but several responses began to be displayed beyond visual range, when wind conditions were appropriate. An accurate discrimination between olfactorily cued response and false positive response is impossible to make without monitoring the physiological responses of the dog. This stage of training is therefore prolonged and 'sloppy' in that mistakes, in the form of administering inappropriate reinforcement, are inevitable.

Food reinforcement was phased out during the last week of training, being used only at the first and last trials and at every trial following the absence of a correct response. Verbal reinforcement was used instead, with much praise being given for correct responding and harsh 'bad dog' being used for incorrect (whistle down) responses.

During the last week of training prior to the demonstration, the target was given a 20-30 minute head start on about half the trials. Every such trial contained 3-6 choice points at trail intersections and one open field crossing. The dogs displayed some tracking ability in being able to follow the target in such situations.

INDEPENDENT TRACKERS

After the initial training common to both groups of dogs, the two independent trackers were put onto a schedule of problems of steadily increasing difficulty. Table I shows the gradation in tracks used. Procedures were the same as those used from the beginning. That is, the target would leave to set the scheduled track and radio the trainer when it was completed. The trainer would then take the dog to the approximate

TABLE I

Difficulty of Track

Week of Contract	Release ¹ Time	Right Angle	Acute Angle	Backtrack	Water Crossing	Age ⁴ Track
7	5	1-4 ² Step (1,2,3,4)				
8	10	1-4 ³ Vary	1-4 Step (1,2,3,4)			
9-10	15	1-4 Vary	1-4 Vary	3-50 yd. Step (3,10,20,50)		
11-17	30	1-4 Vary	1-4 Vary	3-200 yd. Vary	8-50 yd. Step (3,10,20,50)	
18-20	60	1-4 Vary	1-8 Vary	3-200 yd. Vary	8-75 yd. Vary	15-60 Min Step (15, 30,45,60)
21-23	60-90	0-4 Vary	0-4 Vary	10-200 yd. Vary	0-100 yd. Vary	15-60 Min. Vary
24	Tracking broke down; dogs now changed to open fields with runs 10-90 min. (increasing in steps); worked up to combination of open field and wooded area.					
25-end	10-90	0	0	0	0	0

¹Release time - refers to the period between the time the decoy starts his track and when the dog is released.

²Step - refers to systematic increase of difficulty of the variable.

³Vary - refers to randomized use within the variable.

⁴Age of track - refers to the time between the end of the decoy's track and when the dog is released.

point at which the target had started and let the dog cast for the scent. When he located the scent the dog was released and would run off-leash in pursuit of the target, leaving the trainer at the starting point. When the dog reached the target, he would be fed by him. If he failed to reach the target he would be recaptured and sent to the kennels without food until the next trial. With the initiation of each new problem such as backtracking, acute angles, etc., the dog would first be run 3-4 times on leash so that the trainers could be present to provide guidance in establishing successful casting patterns.

Training proceeded smoothly by this method until the total time of the trial began to exceed 1.5-2 hours. The dogs then appeared incapable of performing beyond these time values. It was decided that the problem lay with the limited experience the dogs had been given. All trials to this point had been conducted in densely wooded areas. Under our particular climatic conditions the air borne scent probably lingered for about that long. The animals had never had to use ground scent and were using the apparently easier air scent cues. The problem was solved by moving the training site to a large open area, thus forcing the dogs to use ground scent. Training was begun again with 10 minutes release time, working up to 90 minutes within two weeks. After the first week each trial contained about half open area and half wooded and swampy areas. The dogs were performing at 80% reliability by the time of the demonstration.

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