ASSESSING AVALANCHE RESCUE DOGS' ABILITY TO DETECT HUMAN SCENT WITH CONTAMINANTS ON SITE: DEVELOPING A METHODOLOGY

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ABSTRACT: Avalanche search and rescue dogs are efficient in locating buried humans in avalanche debris when alternative rescue techniques fail. It is poorly understood how surface contaminants affect a dog's scenting ability at the search site. In spring 2014 we developed a practical and repeatable methodology to test three dogs' scenting abilities amidst various surface contaminants including tree debris and gasoline fumes. We conducted a follow-up study in January and February 2015 using 11 additional operational dogs from volunteer search and rescue organizations and ski resorts around the country. The tests included control and contaminant tests on 25-m by 25-m simulated avalanche debris fields. Additionally, we used three operational avalanche dogs to test performance with snow machine exhaust on site. Quantitative analysis reveals mean time to find articles was slightly higher in tree-debris test than control test and slightly higher in control test than gasoline test though no significant differences were found in either control and experiment tests. Additionally, dogs found slightly more articles per second in control test than tree debris test and slightly more articles per second in gasoline test than control test though no significant differences were found. Results indicate mean time taken to find articles was slightly higher in control test than exhaust test and mean articles found per second were slightly higher in exhaust test than control test though no significant differences were found. Analysis of contaminants effects on scenting abilities will provide handlers insight into avalanche dogs' scenting abilities and help enhance the training of avalanche rescue dogs.

KEYWORDS: avalanche rescue dogs, contaminants, scent discrimination

1. INTRODUCTION

There is minimal research on the ability of avalanche search and rescue dogs to locate human scent amidst surface contaminants. Additionally, there are few scientific studies on the reliability of dogs in detecting a number of different substances, most notably illicit drugs and explosives. Using drug detection dogs from the Polish police force, Jezierski et al. (2014) found an 87.7% correct indication rate amongst canines in 1219 experimental tests. They found dogs were equally efficient in searching target scents amidst the presence of non-target odors. Williams & Johnston (2007) found dogs' abilities to detect trained odors amidst non-target odors did not decrease as the number of trained odors increased, but rather dogs required less training as the number of trained odors increased. These studies point to the efficiency of canines' ability to detect trained odors but there are few validated methodologies for quantifying dogs' working abilities (Penman et al., 2007).

Quick rescue response in avalanche accidents is essential to ensure the survival of victims. In an analysis of 217 avalanche reports done by Slotta-Bachmayr (2005), the probability of survival for avalanche victims is 75% and 30% with companion rescue and organized rescue respectively. In organized rescue, burial time is more important than burial depth due to the number of people available to excavate the victim. The burial time when using rescue dogs is shorter than when using probe lines. In fact, one rescue dog can search a one-hectare area in 30 minutes, the time it takes 20 persons to search the same area with a similar probability of detection (Slotta-Bachmayr, 2005).

As an increasing number of backcountry recreationalists and resort skiers enter into avalanche terrain, sometimes without beacons, avalanche dogs can be an important asset to rescue teams (Silva, 2000). An increasing number of snow machines are entering into avalanche terrain with the development of lightweight machines (Tremper, 2008). In fact,

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snowmachiners lead the pack in avalanche fatalities amongst backcountry recreationalist (Chabot, 2002). Additionally, avalanches may entrain trees in their path, leaving trees in the avalanche debris pile.

Given that gasoline fumes from snow machines and tree debris from entrainment may be present on site, it is necessary to understand a dog's scenting abilities amidst the distraction of these contaminants. Weather, including wind, precipitation, air temperature, and snow conditions have been recognized as factors affecting scenting ability in operational dogs, but distractions from contaminants have not been studied (Gould & Latosuo, 2012). Testing the ability of operational avalanche rescue dogs to locate human scent in the presence of contaminants will increase avalanche dog handlers' understanding of their dogs' scenting abilities and can enhance search and rescue training. Furthermore, creating a methodology for testing scenting abilities in the presence of contaminants will allow avalanche search and rescue operations in the United States and Canada to conduct experiments with their own operational teams.

We conducted a follow-up study in Winter 2015 using avalanche dogs from volunteer search and rescue organizations and ski resorts around the country including Alaska, Colorado, Utah, and Montana.

The purpose of this study is to test the hypothesis that introducing a distracting contaminant odor on the surface of avalanche search area will not affect avalanche rescue ability to detect buried human scent in area. This research is approved by the APU Institutional Review Board for ethical use of Animal Subjects.

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2. METHODS

2.1 Test Design

Fourteen avalanche dogs from various ski resorts and rescue dog operations participated in this study in Spring 2014 and January-February 2015. Each operational team participated in one control test and one contaminant test. Dogs participated in either tree-debris, gasoline test or both. Additionally we conducted a pilot study with three dogs using snowmachine exhaust. During the control testing (tests 1 and 3) the canine searched a 25-m by 25-m area searching for four fully buried human-scented articles. The control test controlled for environmental conditions such as weather and snowpack that could affect scenting abilities. The contaminant test followed the control test. The minimum rest period for the canine was 15 minutes and the maximum time was 1 hour. In the second experiment contaminant odors were introduced into the test area. Contaminant tests included tree debris, gasoline fumes and gasoline exhaust. The number of scented articles found and the time taken to find articles were recorded for each team in all four tests. Time recorded began at the moment of the search command and ended when the dog had located all four articles or used the maximum search time of ten minutes.

2.2 Test Subjects

Fourteen mature avalanche dog teams participated in the experiment. Nine dogs participated in the gasoline fumes experiment, eight dogs participated in the tree debris experiment, and three dogs participated in the snow-machine exhaust experiment. Each dog has shown a consistent ability to locate articles in avalanche debris. Each handler described their dog's normal indication for locating articles and distress behaviors prior to the start of the experiment. Handlers could stop participation at any time if their dogs showed signs of distress or discomfort. The order of canines tested for each test day was chosen randomly.

2.3 Articles

Human-scented articles were used in the experiment as a proxy for buried live subjects. Articles are commonly used in avalanche dog training for this purpose. This allows for an easier control of test variables and a safer test set up. Each article was a large size piece of wool and/or polyester clothing. Individuals were instructed to wear it or sleep on it for at 24 hours to ensure adequate amount of human scent on the article for the experiment and canines searched for articles not scented by their own handlers. In each test, four separate human scented articles were buried in the test site at 30cm depth. The burial location of each article was chosen randomly. No articles were re-used for different dogs on a single test day.

2.4 Test Site

The control and experimental tests took place at three locations in Alaska and Utah closed to public ski access without distracting features (i.e. tree islands). Surface snow of all test plots were disturbed a day prior to the first test day in order to simulate an avalanche debris pile. Experimental tests were conducted at least 60m downwind of control test plots. Test plots were 25 m by 25 m in size with clearly marked centers and outside boundaries. The plots were gridded into 25 5 m by 5 m subplots with flags along the outer edges marking the grid lines. After article burial, researchers introduced random human surface scent to control dog tendency to use tracking instead of air scenting as a search method. Article scent percolated for one hour following burial before testing. During the preparation of test sites, test teams were not present.

2.5 Tree Debris Experiment

We used branches of live, freshly cut Mountain Hemlock and other evergreen trees. Branches were scattered across the surface of the 25 m by 25 m plot in a random pattern (Fig. 1). Two of the four article burial sites were randomly selected to have branches scattered directly above the articles. Tree debris scent percolated throughout the test plot for one hour before beginning of experiment.

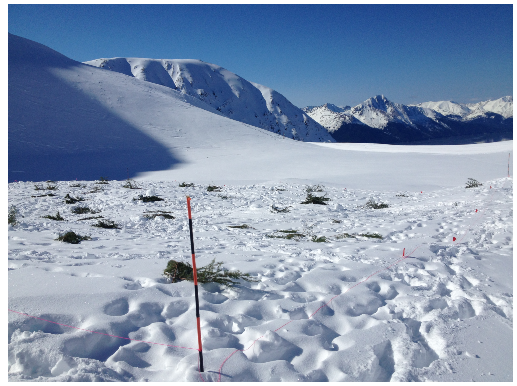

Fig. 1: Handler and operational dog entering tree-debris test site.

2.6 Gasoline Fumes Experiment

We filled five 1-quart paint canisters with one quart of unleaded gasoline (Fig. 2). We submersed each paint canister in the snow in each corner and in the center of each plot. The tops of the canisters were covered with netted galvanized wire to prevent dogs from placing their nose directly in the gasoline. We placed each canister on a stable surface to avoid spilling. Gasoline fumes percolated throughout test site for one hour before the experiment began.

2.7 Snowmachine Exhaust Experiment

We placed a running snowmachine in center-left corner of experiment plot. Volunteers started the snowmachine 5-minutes before testing began and accelerated the engine consistently throughout duration of each test to ensure exhaust fumes percolated in the site.

Fig. 2: Gasoline containers placed in each corner and center of test plot.

2.8 *Control Test*

The team approached the test plots one hour after articles had been buried on the plots. Handlers picked a starting area at a chosen corner of the test plot and commanded their dog to work. Researchers recorded information on data sheets. After control testing, operational dogs took a minimum of a 15-minute rest before proceeding to the contaminant test.

2.9 *Contaminant Test*

Contaminant tests were similar to control tests, with four human-scented articles buried in randomly chosen locations, but for the contaminant tests, odor variables were introduced to the surface. Dog teams were asked to perform a search similar to the previous control test. After the conclusion of the experiment, dogs were done with testing and returned to normal activity with their handler

2.10 *Behavioral Analysis for Tree-Debris and Gasoline Tests*

Nine dogs participating in gasoline tests and eight dogs participating in tree debris test were analyzed on their motivation behavior and ability to actively search the plot for duration of tests based on handler and researcher observations. Motivation behavior is defined as a dog's apparent enthusiasm to search a given area. Actively searching is defined as a dogs' ability to stay on task for duration of test time. Observations on search behavior were recorded and each canine was rated on a 1-5 scale; 1, extremely poor; 2, poor; 3, intermediate; 4, good; 5, excellent.

2.11 *Behavioral Analysis for Exhaust Test*

A video camera on a tripod was placed at the outer edge of the plots in order to record the tests for further qualitative observation in the control and exhaust experiment only. This was due to lack of video quality and camera support during tree-debris and gasoline tests. A volunteer operated the camera to get a more focused view of the dogs. Subjective analysis of video material by the authors and an additional volunteer expert evaluated the behavior of the dogs during control and experiment tests. The evaluation matrix included behavioral indications for motivation, distress, and article identification. These characteristics were derived from discussions with expert dog handlers. The reviewers rated each canine on a 1-5 scale; 1, extremely poor; 2, poor; 3, intermediate; 4, good; 5, excellent.

3. RESULTS

3.1 *Mean Time to Indicate Arcticles*

Results show the mean time taken to indicate human-scented articles was about 30 seconds faster with control test (mean = 306 seconds) than tree debris test (mean = 335 seconds; Wilcoxon rank sum test, W= 29, $p > .05$; Fig. 3).

Mean time taken to indicate human-scented articles was about 60 seconds faster with gasoline test (mean= 351 seconds) than control test (mean = 411 seconds; Wilcoxon rank sum test, W = 39, $p > .05$; Fig. 4). We found no significant differences between both control and experiment tests.

3.2 *Articles Found per Second*

We analyzed average number of articles found per second in order to factor in number of articles found for each test. Dogs found more articles per second in control test (mean = 0.009 articles per second) than tree-debris test (0.005 articles per second; Wilcoxon rank sum test, W= 58.5, $p > .05$). Additionally, dogs found more articles per second in gasoline test (mean = 0.011) than control test (mean = 0.009; Wilcoxon rank sum test, W= 14, $p > 0.05$). We found no significant differences in articles found per second for both control and experiment tests.

3.3 *Snowmachine Exhaust Test*

Results indicate the mean time to find articles in was about 130 seconds faster in control test (mean = 175.8 seconds) than exhaust test (mean = 312.7 seconds (Wilcoxon rank sum test, W=2, $p > .05$; Fig .). We analyzed number of articles found per second in order to factor in number of articles found for each test. Dogs found more articles per second in control test (mean = 0.006 articles per second) than exhaust test (0.004 articles per second; Wilcoxon rank sum test, W= 4, $p > .05$). We found no significant differences in mean time to find articles for both control and exhaust tests

3.4 *Behavioral Analysis for Tree-Debris and Gasoline Tests*

Results indicate dogs scored slightly higher on apparent motivation and ability to actively search area in control test (mean = 4.3) than (than tree-debris test (mean = 3.4) though no significant differences were found (Wilcoxon rank sum test, W = 66, p > 0.01). Results indicate dogs scored very similarly in control test (mean = 4.7) and gasoline test (mean = 4.8; Wilcoxon rank sum test, W= 30.5, p > .01).

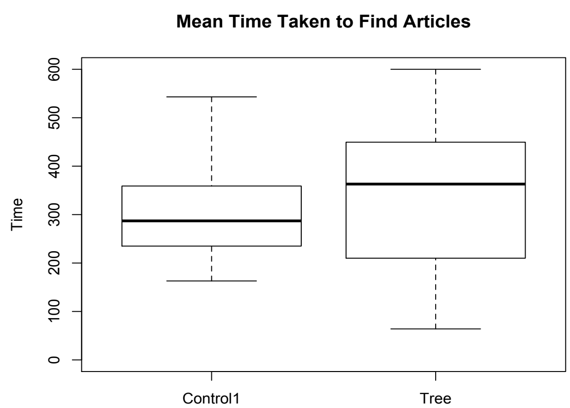

Fig. 1: Mean time taken to find articles indicated by bold line in both control and tree-debris test. Mean time taken to find articles was slightly higher in tree-debris test than control test.

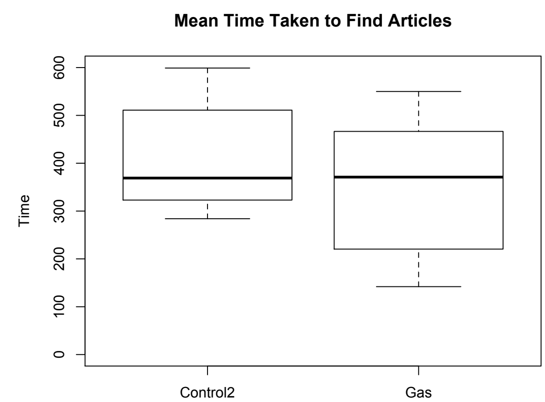

Fig. 2: Mean time taken to find articles indicated by bold line in both control and gasoline test. Mean time taken to find articles was slightly higher in control test than gasoline test.

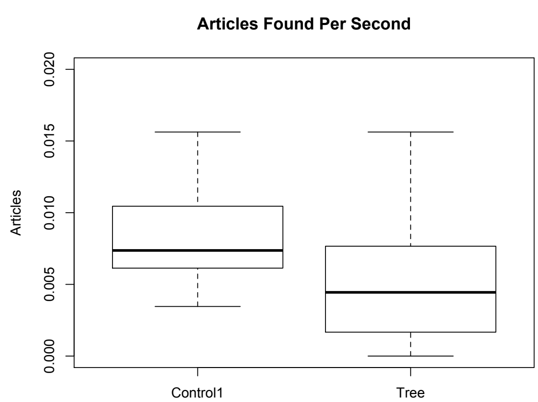

Fig. 3: Mean number of articles found per second indicated by bold line in both control and tree-debris test. Mean articles found per second were slightly higher in control test than tree-debris test.

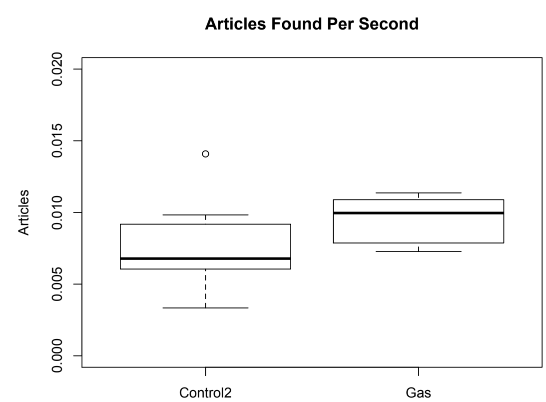

Fig. 4: Mean number of articles found per second indicated by bold line in both control and gasoline test. Mean articles found per second were slightly higher in gasoline test than control test.

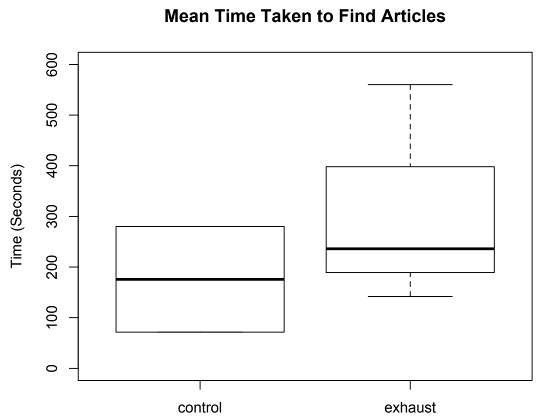

Fig. 5: Mean time taken to find articles indicated by bold line in both control and exhaust test. Mean time taken to find articles was slightly higher in exhaust test than control test.

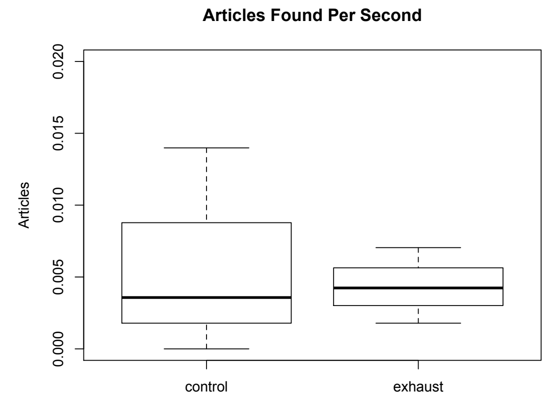

Fig. 6: Mean number of articles found per second indicated by bold line in both control and exhaust test. Dogs found slightly more articles per second in control test than exhaust test.

Fig. 7: Mean behavioral score indicated by bold line in both control and tree test. Mean scores indicate dogs scored higher in control test than tree test.

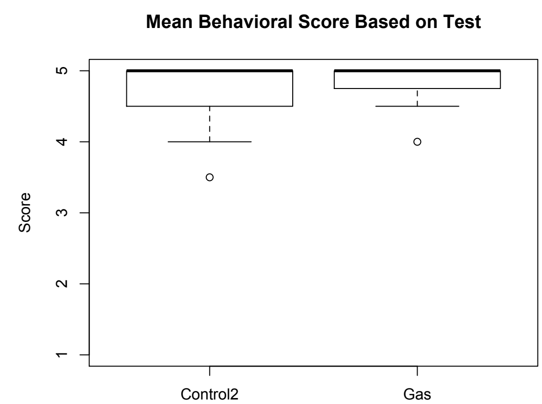

Fig. 8: Mean behavioral score indicated by bold line in both control and gasoline test. Mean scores indicate dogs scored slightly higher in gasoline test than control test.

4. DISCUSSION

The results suggest that dogs' performance was slightly inhibited with tree debris and snow machine exhaust on site while dogs performed slightly better with gasoline on site though no significant differences were found in either test.

The small decrease in performance with tree debris suggests trees may function as a visual or olfactory distraction. It is possible trees provided a different visual context from which dogs usually train in. Their stimulus response pattern or pattern used to associate articles with a reward may have been reinforced in a condition not present with trees. It is also possible tree debris odorants could have been more salient than human odor thus inhibiting dogs from discriminating human odor amidst distracting tree odor. Additionally, tree debris could have deflected the scent plume to periphery of branches, instead of pluming upward in the snow, making it more difficult for dogs to source the articles. Several handlers reported dogs sniffing human odor around tree debris so it is likely scent may be transported along branches. Additionally, the decrease in performance with exhaust on site may be due to olfactory or auditory distraction. All handlers noted they could smell exhaust on site though the noise of the snowmachine engine was very apparent.

The slight increase in performance with gasoline fumes is an interesting phenomenon. This study presented gasoline fumes in controlled and limited amounts. It is possible the concentration of gas may not have been high enough to deter dogs from detecting human scent. In addition to the limited gasoline amount, dogs may have been well exercised and focused in the control experiment leading to an increase in performance in the gasoline test. This suggests future testing may consider more time between control and experiment test though varying weather conditions between tests need to be factored into this scenario. Additionally, dogs may be able to pinpoint human scented articles more efficiently with the contrasting gasoline odors presented in limited amounts. Though results indicated dogs did not perform as well with exhaust complicate this scenario. It is possible the combustion of gasoline product is more volatile than liquid gasoline. A larger sample size in the snow machine exhaust experiment would be useful in understanding the nature of combustion and dog performance. Additionally, future research with varying concentrations of gasoline and snow machine exhaust would be useful in determining the level at which gasoline fumes and exhaust limit dogs' ability to discriminate human odor.

Control tests and contaminant tests were conducted within an hour of each other. This was intended to control for weather variables that could affect scenting ability, such as temperature, wind, and snowpack conditions which may have changed between the test times. Temperature were near or slightly above freezing in all locations throughout January and February. Additionally, wind speed and direction changed slightly throughout the course of each test day. Weather variables in addition to site surface scents created by researchers burying articles, presents limitation to the study.

5. TRAINING CONSIDERATIONS

Given the small decrease in performance with tree-debris and gasoline exhaust on site, training with these contaminants may improve avalanche dogs' search ability in a real search and rescue scenario. The level of demand of a sensory task such as olfactory or visual work will affect the ability to perform a secondary task. Additionally, performance of a learned task will decrease if the sensory information such as human scent has a low contrast with background stimuli ((Helton, 2009). In other words, the energy it takes to discriminate human scent amidst background scents or visual distractions like gasoline exhaust and tree-debris could decrease performance compared with little to no background distraction. An increase in training with stimuli like tree-debris and gasoline exhaust could enhance dogs' ability to discriminate human odor from non-human odor as well as learn to associate visual signs of tree-debris with real avalanche debris conditions and decrease the energy demands it takes to concentrate on discriminating various stimuli. Adding distractive sights, noises and odors on site during the avalanche dog trainings can help desensitize canine to variables that might otherwise affect the performance of the dog during real search missions.

6. CONCLUSIONS

Results suggest dogs' performance was only slightly inhibited with tree-debris and snowmachine exhaust on site and enhanced with gasoline on site with no significant differences found. Further research using more dogs with varying concentrations of gasoline and exhaust may provide more insight into how contaminants affect performance. These results provide insight into avalanche dogs' olfactory capabilities and may enhance the training of avalanche rescue dogs.

AKNOWLEDGEMENTS

Authors would like to thank the following: Alyeska Ski Patrol and Alaska Search and Rescue Dogs for providing canines for these experiments; Wasatch Backcountry Rescue dog school for providing test sites, handlers and canines for the experiments; Alyeska Ski Resort for the permission to use the ideal test site in Glacier Bowl; Patrollers at Alyeska for the help on setup and test days; Stacie Burkhardt for helping with video analysis; Paul Brusseau and Eeva Latosuo for support, mentorship and expertise throughout the project, and BP Exploration for financial support to carry out this study.

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