Using Canine Olfaction to Detect Bovine Respiratory Disease: A Pilot Study

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Objectives

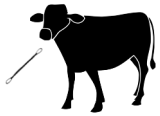
- To train canines to detect bovine respiratory disease (BRD)
- To identify sample characteristics affecting detection accuracy

Introduction

- Dogs can detect a wide variety of bacterial and viral diseases, with high sensitivity, specificity, and accuracy (Juge et al 2021)
- Bovine respiratory disease (BRD) is a leading cause of cattle morbidity and mortality in the US, with an estimated prevalence of 16.2% (USDA, 2013)
- BRD involves multiple viral and bacterial pathogens that exist commensally yet become virulent under stressful condition (Richeson & Falkner 2020).
- Current diagnosis by Clinical Illness Score has a sensitivity of 0.27 (Timsit et al 2016), indicating that there is a need for better diagnostic methods.

Sample Collection

- Nasal swabs were collected from high-risk bulls and steers (n = 395) upon arrival at WTAMU feedlot
- Samples were stored at -80 °C
- Cattle were monitored for 3 months to determine health status
  - Negative: Never treated for BRD
  - Positive: Treated 3+ times or died



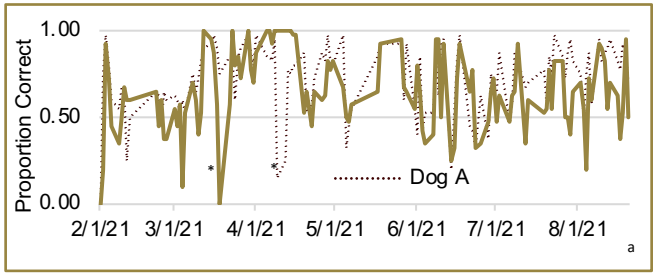
Phase I: Dog Training

- Dogs (n = 2) were trained over 121 sessions, 5 sessions per week, 40 trials per session.
- In each trial, dogs were presented with a lineup of 3 stations and were reinforced with food for giving a sit or nose hold alert on the correct sample.
- 9 stages of increasing difficulty and 2 final evaluation stages.

Figure 1: Sample presentation apparatus. Samples were placed in glass jars inside the PVC containers, supported by tree stands.

Table 1: Stages of training. Dogs progressed to the next stage after reaching 0.90 accuracy in a given session.

Training Stage	Description
1	1 food vs 2 empty jars
2	1 10^{-3} isoamyl acetate vs 2 empty jars
3	1 10^{-4} isoamyl acetate vs 2 empty jars
4	1 10^{-5} isoamyl acetate vs 2 empty jars
4B	1 10^{-5} isoamyl acetate vs 2 mineral oil
5	1 positive vs 2 empty jars
6	1 positive vs 2 blank swabs
7	1 positive vs 1 negative and 1 blank swab
8	1 positive vs 2 negative
9	1 positive vs 2 negative, rotating
10	3 blank (10-trial manipulation check)
11	1 positive vs 2 negative (10-trial practice test)



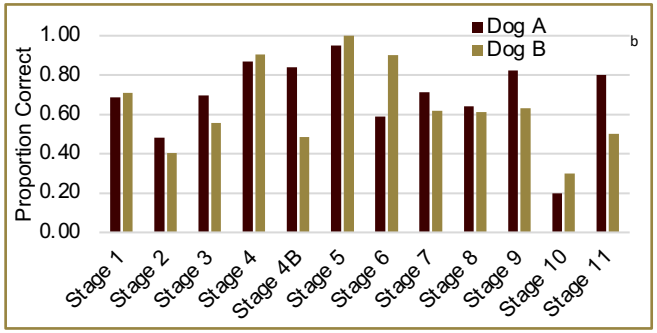


Figure 2: (a) Accuracy per training session by date and (b) by training stage.

The mid-March drop for Dog B and mid-April drop for Dog A (indicated by asterisks) are due to re-training from a "sit" alert to a "nose hold" alert. Overall, the upward trend through late April reflects Stages 1-6; performance on stages 7-8 was inconsistent and cyclical as dogs learned about samples across multiple sessions. Stage 9 occurred from mid-July to mid-August, with less inconsistency but a larger difference between dogs. Stages 10-11 occurred on on the final day of training.

Phase II: Blind Detection Test

- Dog handler, data recorder, and dog, were blind to sample position
- Each dog completed 82 trials, with 82 negative samples and 41 positive samples

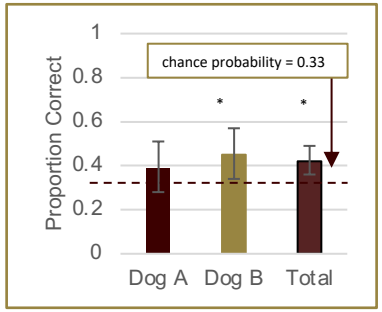


Figure 3: Blind Detection test results. Dog A accuracy was 0.39 (95% CI: 0.28-0.50), Dog B accuracy was 0.45 (95% CI: 0.34-0.57), and overall accuracy was 0.42 (95% CI: 0.34-0.50). Dog B accuracy and overall accuracy were significantly higher than the chance probability of 0.33.

Table 2: Blind Detection test results. Dog performance was better on trials in which samples came from a mixture of steers and bulls than when all samples were from bulls. Accuracy was also higher on trials when samples were from cattle from multiple lots than when cattle were all from one lot or when the positive sample was from a different lot than both negative samples.

		Lot 3	Lot 4	Mixed	Unique Positive	Total
Mixed Sex		0.45	0.50	0.67	0.31	**0.47**
	Dog A	0.36	0.50	0.67	0.25	0.42
	Dog B	0.55	0.50	0.67	0.38	0.52
All Bulls		0.13	0.30	0.50	0.50	**0.34**
	Dog A	0.13	0.30	0.50	0.50	0.34
	Dog B	0.13	0.30	0.50	0.50	0.34
Total		0.37	0.42	0.57	0.39	**0.42**

Conclusions

- Both dogs were able to distinguish between the scents of individual nasal swab samples and repeatedly select a previously reinforced sample
- Dogs did not identify a consistent scent from these samples that was associated with cattle at risk of developing BRD.
- Sex differences and lot differences may have been confounding factors.