A Study to Investigate the Ability of Search and Rescue Dogs to Detect Human Teeth

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1. Introduction

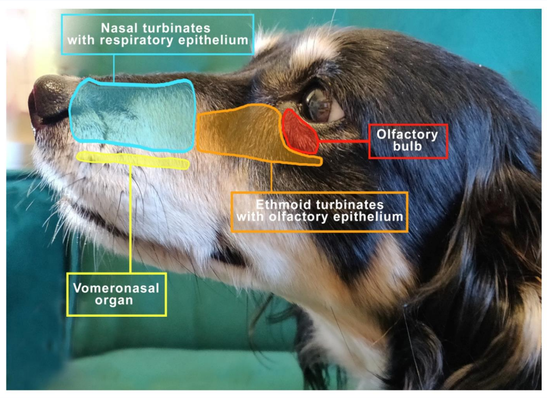


Figure 1. The view to the left of the mesocephalic dog's head shows the distribution of important structures related to respiration and smell [1].

Dogs have a remarkable sensory system that has been applied to various domains including search and rescue (SAR) operations [2]. This is because dogs have up to 300 million odour receptors in their noses [3]. The olfactory bulb, the brain structure that processes these odours, is proportionally 40 times larger than in humans [4].
This study aimed to evaluate the performance of two SAR dogs, R1 and R2, in locating human teeth in different environments. Three sets of experiments were carried out using various materials and depths. The project was carried out in collaboration with Wexford Search and Rescue and their training facilities.

Aims

1. Evaluate viability of human teeth as an olfactory cue for SAR dogs
2. Evaluate canine SAR performance
3. Identify avenues for future research

Tooth Sample

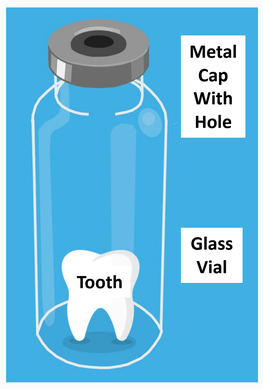


Figure 2. Diagram of tooth inside glass vial with metal cap and hole.

Population Sample

R1
Sex: Neutered Male
Breed: Collie X
Age: 9 years 4 months
Training: Land cadaver, trailing, human remains detection

R2
Sex: Neutered Female
Breed: English Springer Spaniel
Age: 22 months
Training: Land cadaver, river cadaver, trailing, human remains detection

Figure 3. R1 (right), a Collie X male and R2 (left), a female English Springer Spaniel.

2. Methods

Experimental Design

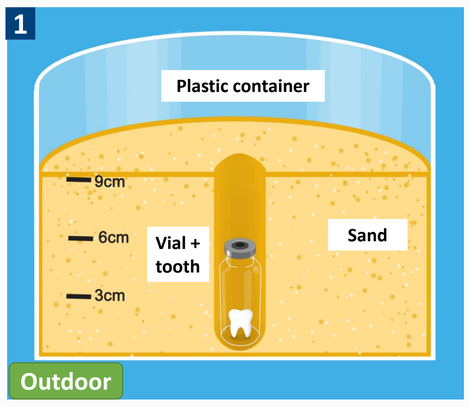


Figure 4.1. Longitudinal view of preliminary study: Sample material placed inside plastic containers at depths of 3cm, 6cm, and 9cm. Vial containing tooth was placed inside hole.

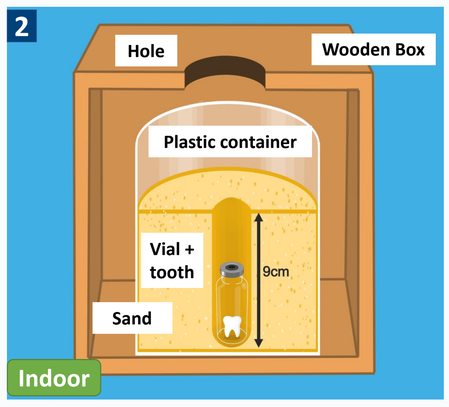


Figure 4.2. Longitudinal view of experiment 2: Sample material placed inside plastic container at depths of 3cm, 6cm, and 9cm. Vial containing tooth placed inside hole. Plastic containers placed inside wooden box containing a hole at the top.

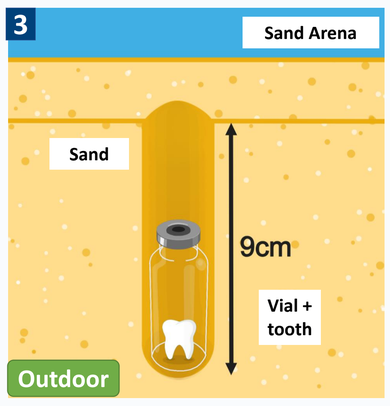


Figure 4.3. Longitudinal view of primary experiment: Stainless-steel T bar was used to dig depths of 3cm, 6cm, and 9cm in soil, sand, and grass. Vial was placed inside hole.

Material Tested	Grit	Stone	Water	Sand	Soil	Grass
Experiment	1 & 2	1 & 2	1 & 2	1, 2 & 3	3	3

The initial experimental design did not have enough structural stability and dogs would often knock over the containers. In the second experiment, the inclusion of wood may have prolonged the retention of the odour in the boxes, even in the absence of a tooth leading to false positives. The dogs performed optimally in the third experiment as this design was the most reflective of a SAR dog's training and deployment environment and had few distractions.

Experimental Procedure

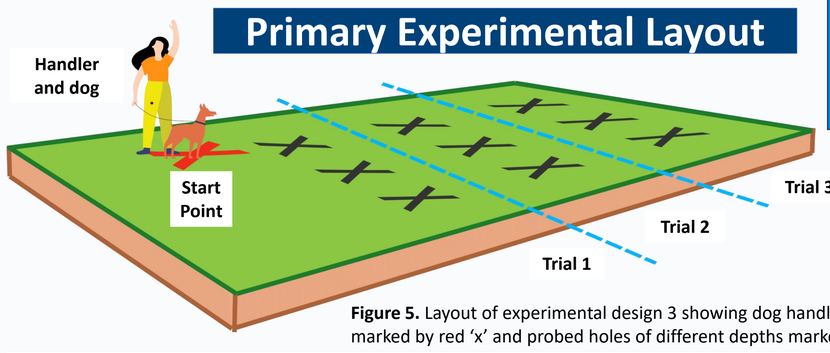
Figure 5.1. Dog and handler stands 1m from stations

Figure 5.2. Handler guides dog to different stations

Figure 5.3. Dog indicates depth with vial and tooth

Figure 5.4 Handler rewards dog

Primary Experimental Layout



Air Temp:16°C
Low Cloud Cover
Wind: 26 km/h SW
Precipitation: 98%
Humidity: 100%

Figure 5. Layout of experimental design 3 showing dog handler pair at start point marked by red 'x' and probed holes of different depths marked by the grey 'x's

The primary experimental setup denoted by 'experimental design 3' involved the use of a stainless-steel T bar to dig varying depths at 1-meter intervals within soil, grass, and sand as illustrated in the above diagram. Three trials were conducted for each material to obtain detection times for 3cm, 6cm, and 9cm, resulting in 9 trials for each dog. A glass vial containing the tooth, handled using gloves to prevent scent contamination, was placed inside the specified depths for each trial and left for 30 minutes to allow the scent to disperse. The experimental procedure previously described was consistently applied to every trial.

Ethical Approval was granted by UCD: Ref. No.: UTMREC-SM-E-23-304-Benny-Davis

3. Results

R1 Detection Times

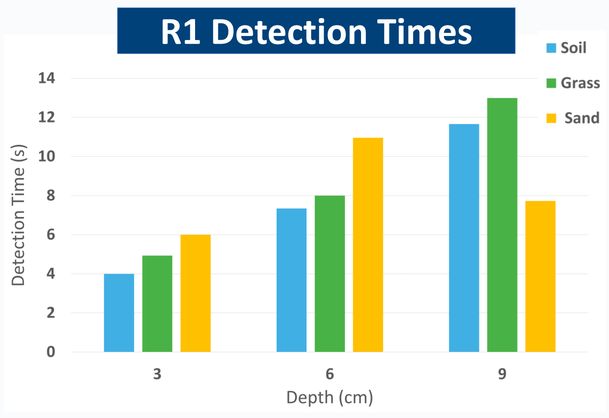


Figure 6.1. Bar chart representing detection times for R1 for depths of 3cm, 6cm, and 9cm in soil, grass, and sand in experiment 3. Note the slight inconsistencies for sand trials

R2 Detection Times

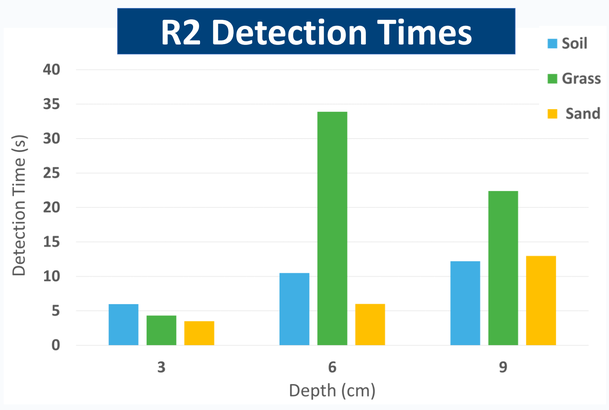


Figure 6.2. Bar chart representing detection times for R2 for depths of 3cm, 6cm, and 9cm in soil, grass, and sand in experiment 3. Note the inconsistencies for grass trials

Mean Detection Time R1 vs R2

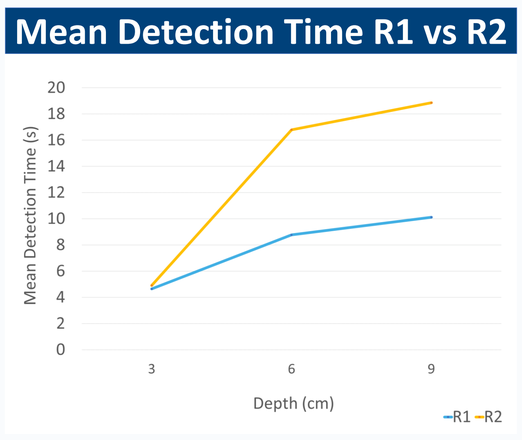


Figure 7. Line graph representing mean detection times for R1 and R2 at 3cm, 6cm, and 9cm in experiment 3.

Standard Deviation R1 vs R2

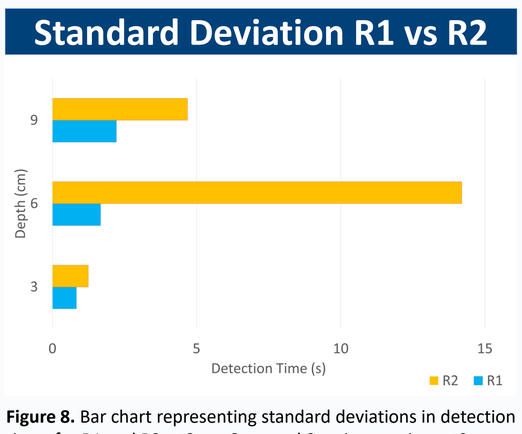


Figure 8. Bar chart representing standard deviations in detection times for R1 and R2 at 3cm, 6cm, and 9cm in experiment 3.

Conclusion

The study findings confirm that human teeth are a viable scent source for SAR dogs. Mean detection times indicated that greater depths generally led to increased detection times, a finding consistent with previous canine olfactory research [5]. Certain anomalies, particularly in grass trials, may warrant further investigation.

Implications

1. **Finding missing or deceased persons** who may have lost a tooth due to injury, age, illness, or other factors.
2. **Identifying human remains** by crossmatching teeth with dental records.
3. **Relevant to SAR operations and forensic odontology** because teeth can last for thousands of years, while human flesh decays rapidly [6].
4. **Contributed to the growing body of literature on canine olfactory detection**, providing valuable insights into the effects of depth and material on detection time.

Limitations

- Age, Breed, and Sex Variability
- Environmental Factors
- No experimental Controls
- Small Sample Size
- Subjectivity in Observation
- Training Variability
- Single Type of Human Remains
- Variability in Performance of Dogs
- Little Replication
- Small Experimental Layout

Discussion

R1's faster and more consistent detection times likely stem from his extensive experience in SAR operations. Both dogs performed similarly at 3cm and 9cm depths. However, R2 had significantly longer detection times at 6cm, with a high standard deviation, particularly in the grass trial, possibly due to the presence of other animal scents. Environmental factors such as humidity, temperature, and wind direction may have also affected the dogs' performance on the day.

Future research could involve a larger sample size consisting of different breeds, ages, and abilities, and could investigate different environmental conditions such as temperature, wind speed, or humidity.

4. References

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