Do Dogs Use Their Nose? Investigating Olfactory Perception in the Domestic Dog

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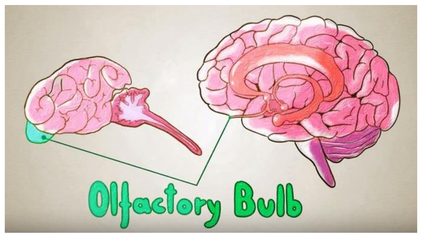
Overview

Dogs (*canis familiaris)* are well known for their exemplary olfactory abilities. But under what conditions will dogs actually utilize these abilities? The present research explores this question by assessing whether shelter dogs are capable of noticing and choosing greater over smaller quantities of food through olfaction alone, when previously provided with an investigation period.

Background

Comparative Anatomy

- The domestic dog's nasal tissue can have over 200 million sensory receptor sites dedicated to receiving smell molecules. Humans only have 6 million (1).
- Olfactory information is directly sent to and processed by the olfactory bulb which makes up 1/8 of the dog's total brain mass (1).
- The olfactory bulb is proportionally greater than the size of the human occipital lobes which are responsible for processing visual stimuli (1).



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Vision vs Olfaction in Decision Making

- It has generally been assumed that dogs rely more on olfaction than vision to navigate, problem solve, and understand their environments.
- Two pieces of resent research have complicated this preconception.
  1. Dogs can visually discriminate larger and smaller quantities of food when the ratio between quantities is small and when the numerical distance between quantities is large, following Weber's Law (3).
  2. Dogs have only been marginally successful at discriminating large and small quantities of food, with a 1:5 and 0:5 ratio, using olfactory cues alone (4, 5).

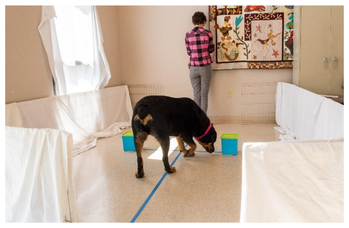
Limitations of Previous Olfactory Research

- Previous olfactory research has not explored how dogs would behave or perform if given an open investigation of the food quantities followed by a brief retention interval before making a choice.
- Likewise, pet dogs have been the focal group of previous canine olfactory research, leaving the olfactory experience of shelter dogs as an unexplored topic.

Method

Dog subjects were recruited through the Capital Area Humane Society. Twelve dog subjects successfully completed the experimental task across two sessions of five trials. Each trial involved three phases.

1. **Investigation Phase**
Dog subjects were released into an ~10ftx8ft X-Pen where they briefly investigated two covered opaque containers on the floor for ~10-20secs. Containers were ~5ft away from the start point and ~3ft apart from each other. One container held five hotdog treats; the other held one hotdog treat. Side placement of the containers were counter-balanced across trials.



2. Retention Interval
Dog subjects were led out of the X-Pen and brought behind a screen for ~20secs. While the subjects were behind the screen, an experimenter removed the lids from the containers inside the testing area.

3. Choice Phase
Dog subjects were led back to the X-Pen and rereleased to make a food choice. Once the dog chose a container to eat from, the trial ended and the unchosen container was covered by an experimenter.

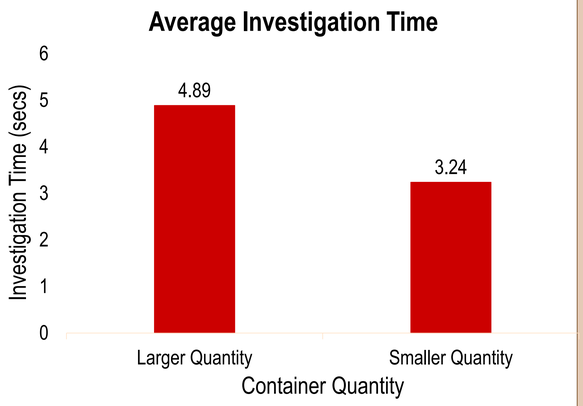
Predictions

It was predicted that:

- Dog subjects would show greater interest in the larger quantity container during the investigation phase
- Dog subjects would choose to eat from the larger quantity container during the choice phase
- Dog subjects would show evidence of learning by selecting the larger quantity container more often in session two.

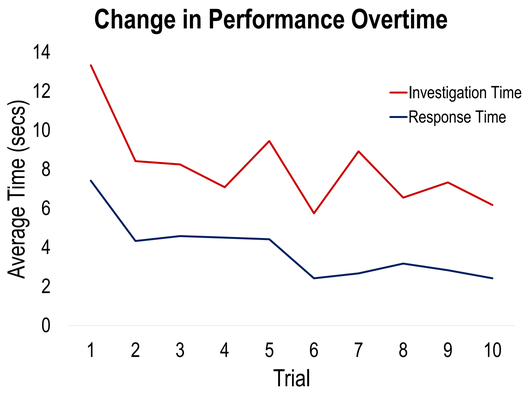
Results

Investigation Time
Dogs spent significantly more time investigating the larger quantity container compared to the smaller quantity container during the investigation phase, (Wilcoxon Signed Rank, p=0.000). Likewise, dogs were more likely to investigate the larger quantity container last before leaving the testing area, (2-tailed binomial, p=0.026). These findings support our prediction that dogs would show greater interest in the larger quantity container during the investigation phase.



Food Quantity Choice
Dog subjects had no preference for either the larger quantity container (selected 55% of the time) or the smaller quantity container during the choice phase, (2-tailed binomial, p=0.315).

Change in Performance
There was a non-significant improvement of performance between session one and session two. Dogs chose the larger quantity 53% in session one, (2-tailed binomial, p=0.0699) and 57% in session two, (2-tailed binomial p=0.366). However dog subjects' performance did change in terms of how quickly they completed the task. As subjects performed more trials their investigation time decreased, (Spearman's rho, r= -0.302, p=0.001), as did their response time during the choice phase of the experiment (Spearman's rho, r= -0.370, p=0.000).



Conclusion & Explanations

Dog subjects were unsuccessful at choosing the larger food quantity despite showing greater interest in the larger quantity during a previous investigation period. Here are some possible explanations for this finding:

The Role of Experience:
Due to domestication, dogs often look to humans to solve problems and form decisions for them. Therefore, dog subjects may have performed inconsistently due to having limited human guidance in the experimental tasks. Because shelter dogs were used as subjects, none of the dogs had any known formal scent detection training. It may be that, without proper human guidance and formal training, dogs cannot complete decision tasks that strictly require olfaction. Future research will have to look at how scent-trained canine subjects perform at quantity discrimination olfactory tasks.

Behaviorist Explanation:
In this experiment dog subjects were rewarded regardless of the choice they made, this in turn could of reinforced their inconsistent behavior. Indeed the fact that their task completion time decreased across trials suggests they were learning something about the task.

Neurocognitive Explanation:
While it is yet to be fully understood how mammalian brains utilize olfactory information, the results of this experiment could be due to a discrepancy between the "hardware" of the dog nose itself and the "software" of the dogs' brain and cognitive capabilities. Dogs have an extraordinary nasal "hardware" system which is capable of receiving many different types of olfactory input, however it could be that aspects of their cognitive "software," are too limited—yielding them incapable of planning and forming decisions through olfaction alone (1). This discrepancy between hardware and software could be a result of domestication. Future research will have to assess whether wolves and other wild canines are capable of quantity discrimination olfactory tasks.

Future Directions:
While the present research has left many potential directions to go in, our next experiment will investigate whether dogs can discriminate high reward vs. low reward foods using olfaction alone. It could be that dogs can make decisions using olfaction, but only if the smells are different.

References

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