Investigation of Rudimentary Mathematics in Domestic Dogs: Can dogs subtract?

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Introduction

Numerical competency has been demonstrated in a variety of animals (Tennesen, 2009). In particular, West and Young (2002) demonstrated possible numerical competency in domestic dogs. This ability in "man's best friend" can be important as humans continue to train dogs for more advanced cognitive tasks, such as rescue and therapy.

West and Young (2002) employed simple addition trials ("1+1=2," "1+1=1," and "1+1=3") to investigate dogs' numerical competency. Using the preferential looking technique first utilized by Wynn (1992), West and Young (2002) determined that domestic dogs spent longer looking at the results of a trial with an unexpected result than a trial of an expected result, suggesting at the least that dogs have the numerical competency to tell a little from many.

However, West and Young (2002) employed only a between-groups analysis, the results of which may be skewed by individual differences in motivation. Thus, the current study presented each dog with three simple subtraction trials ("3-1=2," "3-1=1," and "3-1=3") to extend West and Young's (2002) findings and control for dogs' preference to look longer when more treats are presented regardless of how much more.

Research Purposes

1. To extend West and Young's (2002) investigation of domestic dogs' numerical competency
2. To improve validity by using a within-groups design
3. To utilize subtraction trials to demonstrate enhanced numerical competency in dogs

Hypothesis

Dogs will spend more time looking at trials with unexpected results (i.e.: 3-1=1 and 3-1=3) than expected results (i.e.: 3-1=2).

Methods

Participants. People volunteered their dogs for this study, resulting in 16 dogs, one of which did not meet age criteria and was excluded. The final sample included 15 dogs from 8 months to 110 months in age (M=40, sd=29.19) with owner-reported temperaments (13 responsive, one nervous, and one independent).

Materials. A cardboard screen raised and lowered with pullies concealed the test area. The test area contained seven Styrofoam bowls placed 0.1m apart. Milkbone dog treats were placed on three bowls, and the remaining bowls concealed one bone each. A Panasonic video camera on a two-foot tripod recorded the dogs. Dogs received Pupperoni dog treats as reward.

Figure 1. View of test area with screen raised.

Procedure. The dog and owner were met outside of the lab and the owner was informed that a camera would be recording the dog and to keep the dog on a tight leash to prevent it from entering the test area. In the lab, the owner filled out consent and demographic forms and the dog was habituated to the room and procedures.

Trials. Each dog randomly received one of six orders of three trials:
- *3-1=1; less than expected.* The screen was raised and three bones were presented to the dog whose gaze was measured until the dog looked away for more than two seconds (baseline). The screen was lowered and the researcher removed one bone from behind the screen and hid a second in a pocket, showing only the first to the dog. The screen was raised and the dog's gaze on the bones was again measured (trial).
- *3-1=2; expected.* The researcher removed one bone and showed it to the dog.
- *3-1=3; more than expected.* The researcher pulled a bone from his or her pocket while behind the screen and showed it to the dog.

Between each trial, the test area was set up with three bones and the dog was given a treat.

Results

Inter-rater reliability. Three individual raters were instructed to view the videos (blind to the trial) and document the time each dog spent gazing at the test area. A gaze was defined as a look at the test area until the dog looked away for more than two seconds.

Inter-rater reliability ranged from 0.42 to 0.94, sd = 0.18.

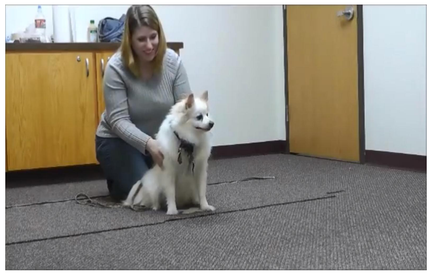

Figure 2. View of dog from camera.

Main effects of trials. Trials were analyzed with paired-samples t-tests, in which the time the dog spent looking at the initial presentation of treats was compared to the amount of time the dog spent looking at the test area after manipulation.

No significant effects were found: **Trial 3-1=2,** t(14) = 0.77, N = 15, p = 0.45; **Trial 3-1=1,** t(14) = 1.52, N = 15, p = 0.15; **Trial 3-1=3,** t(14)= -0.86, N = 15, p = 0.41.

Table 1
Preferential looking times in seconds averaged across raters

Presented	3-1=1		3-1=2		3-1=3	
	Baseline	Trial	Baseline	Trial	Baseline	Trial
Participant						
01	7.33	4.67	8.00	3.00	3.33	11.00
02	8.67	9.00	2.00	2.33	1.00	11.00
03	2.67	1.33	2.33	0.67	1.00	0.33
04	3.00	5.00	2.67	3.67	3.33	2.33
05	0.67	0.33	1.00	1.33	1.00	2.00
06	2.33	6.00	11.00	7.33	2.67	7.00
07	1.33	1.00	3.67	4.67	7.67	4.67
08	1.67	1.33	1.00	3.33	6.33	2.00
09	2.00	2.00	3.00	3.00	1.33	3.33
10	1.00	1.00	1.33	1.00	1.33	1.33
11	2.00	2.00	1.33	1.67	1.00	1.00
12	2.00	0.67	1.00	0.33	2.00	0.33
14	0.67	1.33	0.67	1.33	0.67	3.00
15	5.67	1.67	4.00	2.67	3.00	1.33
16	0.67	0.67	1.00	0.67	2.00	0.67
Means	**2.78**	**2.53**	**2.93**	**2.47**	**2.51**	**3.42**

Conclusions

Results of the current study do not support numerical competency in dogs. However, the difference in significance levels between "3-1=2" and "3-1=3" trials and "3-1=1" trials may suggest that dogs have competency in detecting greater differences (from three to one) than fewer to no differences (from three to two or three to three). A larger sample may find support for this hypothesis.

As the current study did not employ addition trials, it is not confirmed if a within-groups analysis will affect the results of West and Young (2002). It is possible that dogs have a greater ability to notice addition of stimuli than subtraction of stimuli. Future replications may find support for this hypothesis.

Limitations. One limitation was the variability of inter-rater reliability, suggesting that our mean estimates were not reliable.
Some dogs were also easily distracted by researchers present in the room, which may have affected motivation to look at the test area.

Future directions. In the future, we plan to correct our rating methods to create greater inter-rater reliability. We will also prevent researchers from distracting dogs, possibly by removing them from the field of vision. Future research should continue to expand on these methods to fully investigate numerical competency of dogs.

References

Tennesen, M. (2009). Animals by the Numbers. *Scientific American, 301*, 23-24.
West, R. E., & Young, R. J. (2002). Do domestic dogs show any evidence of being able to count?. *Animal Cognition, 5*, 183-186.
Wynn, K. 1992. Addition and subtraction by human infants. *Nature, 358, 749-750.*

Contact Information

For more information, visit the Canine Cognition Lab at: caninecognition.webs.com