



Research

Cite this article: Udell MAR. 2015 When dogs look back: inhibition of independent problem-solving behaviour in domestic dogs (*Canis lupus familiaris*) compared with wolves (*Canis lupus*). *Biol. Lett.* **11**: 20150489. <http://dx.doi.org/10.1098/rsbl.2015.0489>

Received: 9 June 2015

Accepted: 25 August 2015

Subject Areas:

behaviour, cognition, evolution

Keywords:

dog, wolf, cognition, social behaviour, domestication

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Electronic supplementary material is available at <http://dx.doi.org/10.1098/rsbl.2015.0489> or via <http://rsbl.royalsocietypublishing.org>.

Animal behaviour

When dogs look back: inhibition of independent problem-solving behaviour in domestic dogs (*Canis lupus familiaris*) compared with wolves (*Canis lupus*)

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Domestic dogs have been recognized for their social sensitivity and aptitude in human-guided tasks. For example, prior studies have demonstrated that dogs look to humans when confronted with an unsolvable task; an action often interpreted as soliciting necessary help. Conversely, wolves persist on such tasks. While dogs' 'looking back' behaviour has been used as an example of socio-cognitive advancement, an alternative explanation is that pet dogs show less persistence on independent tasks more generally. In this study, pet dogs, shelter dogs and wolves were given up to three opportunities to open a solvable puzzle box: when subjects were with a neutral human caretaker, alone and when encouraged by the human. Wolves were more persistent and more successful on this task than dogs, with 80% average success rate for wolves versus a 5% average success rate for dogs in both the human-in and alone conditions. Dogs showed increased contact with the puzzle box during the encouragement condition, but only a moderate increase in problem-solving success. Social sensitivity appears to play an important role in pet and shelter dogs' willingness to engage in problem-solving behaviour, which could suggest generalized dependence on, or deference to, human action.

1. Introduction

In recent years, the social behaviour of domestic dogs, *Canis lupus familiaris*, has been widely studied. While individual and population variation exists [1,2], pet dogs have demonstrated the capacity to respond to a wide range of human gestures and actions [3]. There is also evidence that human-socialized wolves can succeed on tasks requiring the use of human gestures [4]. However, differences in social behaviour have been identified. Compared with wolves, dogs have a prolonged sensitive period for social development, increasing the ease with which they bond with other species [5,6]. Dogs also retain juvenile traits into adulthood [6], including behavioural traits that facilitate the human–canine bond such as prolonged gaze [7].

Dogs' responsiveness to human social cues has frequently been considered a cognitive advancement. However, the majority of studies conducted on canine social cognition have designated the social response as the *correct response*, which could mask evidence of indiscriminate, or heightened, social reliance; something that would be more apparent in contexts where the independent response provided greater reward. For example, in 2003, Miklósi *et al.* [8] asked what nine pet dogs and nine human-socialized wolves would do when confronted with an 'unsolvable task', where trapped food could not be obtained through individual effort. While wolves persisted on the task, dogs quickly gave up and gazed at a nearby human. This has traditionally been interpreted as the clever, socially advanced, response to this problem. However, it is equally possible that dogs

simply fail to persist on challenging problem-solving tasks in general, or when in the presence of a social partner.

This study asked what pet dogs, shelter dogs and wolves would do when confronted with a 'solvable' puzzle box. If dogs show persistence in this context, then 'looking back' behaviour described in prior studies might, indeed, represent a unique strategy that dogs employ when faced with an unsolvable problem. However, if the same pattern of behaviour is observed (wolves persist, dogs do not) dogs' response could be due to a predisposed hypersensitivity to social cues, or conditioned inhibition of problem-solving behaviour. The latter would be especially likely if persistence on the task increased when encouraged by a caretaker. Furthermore, if lack of persistence is due to contingencies associated with a pet dog's home environment (i.e. a history of scolding for independently obtaining food items), shelter dogs might represent an intermediate group—showing greater social sensitivity than wolves, but less than pet dogs—owing to reduced human interaction in the shelter setting. Prior studies have shown that dogs living in a shelter are initially less responsive to some human gestures than pets [2]; therefore, it is possible that human presence would have less of an influence on their problem-solving performance as well.

2. Material and methods

(a) Subjects

Ten adult pet dogs living in homes were tested individually indoors at a location familiar to them. Ten adult shelter dogs, living in indoor kennels, were also tested individually indoors at a quiet location familiar to them at the shelter. All shelter dogs exhibited signs of prior human-socialization, were friendly towards humans, and would take food from the experimenter without fear or aggression. Ten adult human-socialized wolves were tested individually in an enclosure familiar to them. These wolves were hand reared by humans from two weeks of age, received daily human contact and received basic obedience training at the level of a typical pet dog as juveniles (sit, lie down, target, etc.). Additional subject details can be found in the electronic supplementary material.

(b) Phase 1: the solvable task

Each subject was called by the experimenter and allowed to sniff a 5-cm-long piece of summer sausage, which was then placed in a puzzle box (figure 1). Once the box was set on the ground, with lid snapped in place, the experimenter did one of two things:

Alone condition: the experimenter left the testing area.

Human-in condition: the experimenter took three steps back to a marked location, stood neutrally and looked at the puzzle box.

In both conditions, the box could be opened. All subjects experienced both conditions, each lasting 2 min, with a short break, just long enough to reset the puzzle and video camera, in-between. Condition order was counterbalanced. For pet dogs and wolves, the experimenter was the owner/caretaker. For shelter dogs, the experimenter was a familiar human.

(c) Phase 2: role of encouragement

Subjects that failed to solve the puzzle box in both the alone and human-in conditions were provided with a third attempt identical to the human-in condition with one added factor: the human was instructed to continuously encourage the subject to engage with the puzzle box using words and gestures. If failure could be attributed to inhibition of independent problem-solving



Figure 1. Baited puzzle box.

behaviour, it was predicted that encouragement would result in more persistence and increased success on the task.

(d) Behaviour coding

The puzzle box was considered solved when the lid to the container was fully off or when the food left the container, whichever came first. All trials were video recorded. Latency to touch the box, per cent of time spent gazing towards the box and human, per cent of time touching the box and time to solve were coded from video, with 30% of trials double coded by an independent coder. Inter-rater reliability was 93% across time-based measures, 100% for whether the task was solved.

3. Results

(a) Human-in condition

One pet dog and no shelter dogs solved the puzzle box. Conversely, eight out of 10 wolves successfully solved the puzzle box. A 2×3 Freeman–Halton extension of the Fisher's exact probability test [9] confirmed that this difference was statistically significant ($p = 0.0001$).

On average, wolves showed more persistence on the task, spending a significantly greater percentage of trial time in physical contact with the box than pet or shelter dogs (Kruskal–Wallis test, $H_2 = 19$, $p < 0.0001$; Welch tests: wolf versus pet dog, $p < 0.0001$, wolf versus shelter dog, $p < 0.0001$, shelter versus pet, $p = 0.08$; figure 2), as well as significantly more time looking at the box compared with both dog groups (Kruskal–Wallis test, $H_2 = 15.71$, $p = 0.0004$; Welch tests: wolf versus pet dog, $p = 0.0001$, wolf versus shelter

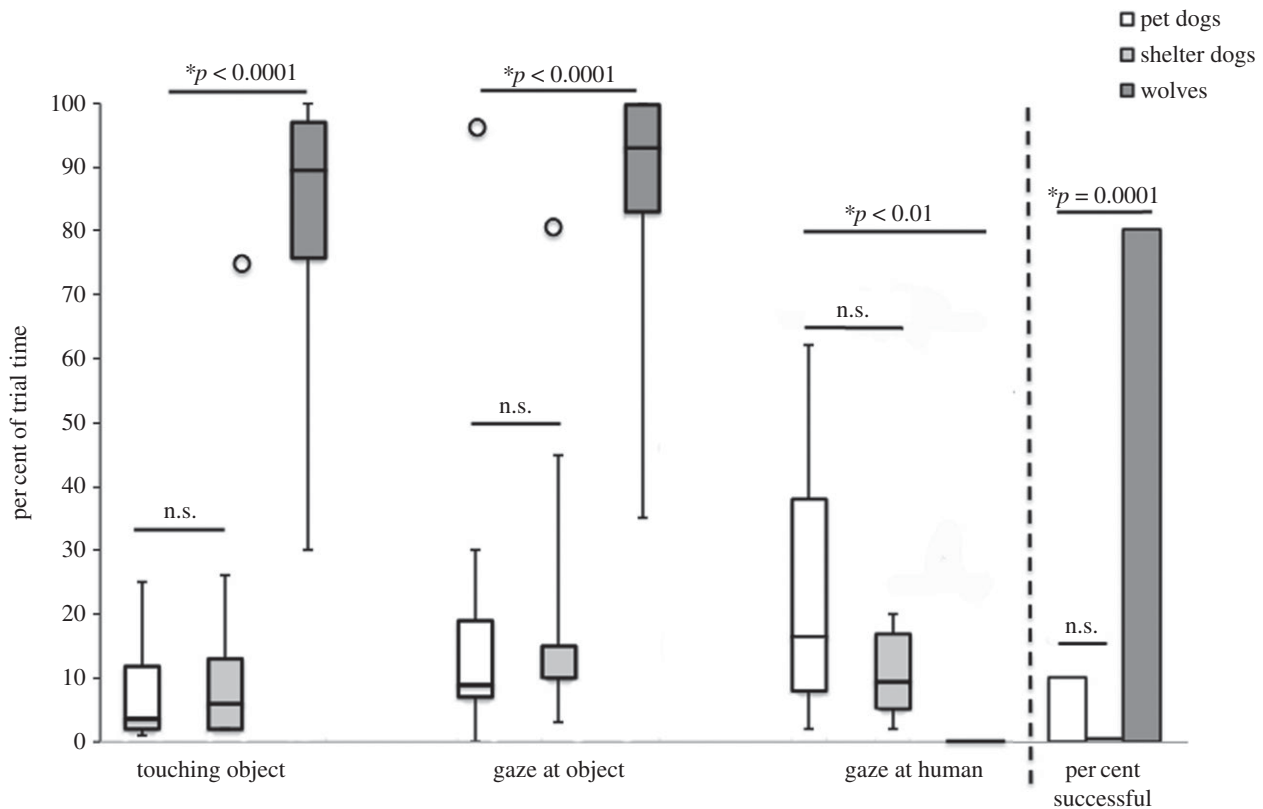


Figure 2. Solvable task performance with a neutral human present. Average scores displayed as median values. Boxes represent the interquartile range, and whiskers represent performance range with circles indicating extreme values. n.s., not significant.

dog, $p = 0.0001$, shelter versus pet dog, $p = 0.99$). Dogs spent significantly more time looking at the human than did wolves (figure 2; Kruskal–Wallis test, $H_2 = 20.22$, $p < 0.0001$; Welch tests: wolf versus pet dog, $p = 0.005$; wolf versus shelter dog, $p = 0.0008$; shelter versus pet dog, $p = 0.09$).

Importantly, all subject groups showed initial interest in the puzzle box (median initial approach times: pet dogs = 0.84, shelter dogs = 0.69, wolves = 1.66 s) with no significant difference between groups (Kruskal–Wallis test, $H_2 = 5.51$, $p = 0.06$), suggesting that dogs' lack of persistence and poor performance was unlikely owing to inattention or absence of interest in the box.

(b) Alone condition

Similar to the human-in condition, eight out of 10 wolves solved the puzzle box (across both conditions every wolf solved the box at least once). Only one shelter dog and no pet dogs solved the task (2×3 Freeman–Halton extension of the Fisher's exact probability test, $p = 0.0001$). Again, all groups showed equivalent initial interest in the puzzle box (median initial approach times: pet dogs = 0.92, shelter dogs = 1, wolves = 1.54 s; Kruskal–Wallis test, $H_2 = 2.91$, $p = 0.23$). However, even when alone dogs spent significantly less time trying to solve the puzzle than wolves (per cent time touching box, Kruskal–Wallis test, $H_2 = 17.11$, $p = 0.0002$; Welch tests: wolf versus pet dog, $p < 0.0001$, wolf versus shelter dog, $p < 0.0001$, shelter versus pet, $p = 0.16$).

(c) Encouragement condition

The nine pet dogs and nine shelter dogs that failed to solve the puzzle in both of the first two conditions continued on to the encouragement condition. One pet dog had to be dropped due to experimental error.

Four of the nine shelter dogs and one of the eight pet dogs solved the puzzle box when encouraged by a human. While an improvement over the performance of dogs in the neutral human condition, this change was not statistically significant (two-tailed Fisher's exact test, $p = 0.07$). There was, however, a significant increase in the amount of time dogs spent in contact with the puzzle box during the encouragement condition (two-way paired t -test, $t_{16} = 6.2$, $p < 0.0001$), and the amount of time spent looking at the box (two-way paired t -test, $t_{16} = 8.6$, $p < 0.0001$) compared with the neutral human condition.

4. Discussion

As in previous studies [7,8], dogs spent significantly more time gazing at the human compared with wolves. However, they also failed to persist on the independent problem-solving task, even though, in this case, the task was solvable. This suggests that dogs may not have been responding to the unsolvable nature of prior 'unsolvable task' experiments [8], but instead give up prematurely on such tasks in general—possibly owing to a hypersensitivity to, or dependence on, social cues. Conversely, wolves persisted on the task until the puzzle was solved, independent of human presence.

While an increased proclivity for looking at humans may represent a cognitive shift in dogs compared with wolves [6], it does not necessarily suggest cognitive advancement, as these results suggest dogs' heightened social response may, in turn, interfere with independent problem-solving behaviour. The fact that both shelter and pet dogs failed to persist on the task, except when encouraged to do so by a human, suggests that social inhibition of independent problem-solving behaviour may be even more generalized than human gesture responsiveness, something that is greatly influenced by a dog's

current living environment [2]. It should be noted that in a pilot study an eight-week-old puppy was able to open the puzzle box, thus failure was unlikely due to physical limitations. However, this may suggest that problem-solving inhibition in dogs develops or is learned with age; therefore, further developmental studies are warranted.

Lifetime factors are likely important. Nearly all of a pet dog's resources are directly controlled by human owners [3], and their day-to-day behaviours are often more regulated than captive wolves' [6]. Thus, wolves may have more opportunities for independent problem-solving within their environment, and a greater history of success obtaining trapped food independently owing to their relative strength. Consequently, dogs' behaviour may be the product of conditioned dependence on humans, or conditioned inhibition of independent problem-solving behaviour when confronted with a novel task. Prior studies have demonstrated that the presence of a human increases dogs' interaction with commercial dog toys [10] and can decrease interaction with forbidden items [11]. Therefore, dogs may err on the side of caution with novel tasks, inhibiting independent interaction in the absence of a social directive; a choice that might result in greater long-term success in human homes. The finding that dogs persisted significantly longer on the task,

leading to more individual successes, when encouraged by a familiar human lends additional support to this hypothesis.

Consequently, populations of dogs trained to engage in independent problem-solving behaviour, e.g. search and rescue dogs, those living outside of human homes, e.g. feral dogs, or even young puppies might perform differently and should be investigated in future studies. Future research should also consider different types of problem-solving tasks, and apparatuses, to more fully characterize the domestic dogs' problem-solving abilities, as well as the relative role of human influence in different contexts.

Ethics. All procedures performed in this study were in accordance with national and international guidelines, and received institutional IACUC ethical approval (Flagler College IACUC no. 133711-2012-1, Oregon State University IACUC no. 4444). This study adheres to the Association for the Study of Animal Behaviour/Animal Behavior Society Guidelines for the Use of Animals in Research.

Data accessibility. Datasets supporting this article have been uploaded as part of the electronic supplementary material.

Competing interests. I have no competing interests.

Funding. I received no funding for this study.

Acknowledgements. I thank Wolf Park, Flagler Humane Society, and the owners and pets who participated. Thanks to Jennifer Gibson, Stephanie Scavelli and Courtney Kutzler for assistance with data collection and video coding.

References

- Gacsi M, Kara E, Belenyi B, Topal J, Miklósi A. 2009 The effect of development and individual differences in pointing comprehension of dogs. *Anim. Cogn.* **12**, 471–479. (doi:10.1007/s10071-008-0208-6)
- Udell MAR, Dorey NR, Wynne CDL. 2010 The performance of stray dogs (*Canis familiaris*) living in a shelter on human-guided object-choice tasks. *Anim. Behav.* **79**, 717–725. (doi:10.1016/j.anbehav.2009.12.027)
- Udell MA, Wynne CDL. 2008 A review of domestic dogs' (*Canis familiaris*) human-like behaviors: or why behavior analysts should stop worrying and love their dogs. *J. Exp. Anal. Behav.* **89**, 247–261. (doi:10.1901/jeab.2008.89-247)
- Udell MAR, Spencer J, Dorey NR, Wynne CDL. 2012 Human-socialized wolves follow diverse human gestures. . . and they may not be alone. *Int. J. Comp. Psychol.* **25**, 97–117.
- Klinghammer E, Goodman P. 1987 Socialization and management of wolves in captivity. In *Man and wolf: advances, issues, and problems in captive wolf research* (ed. H Frank), pp. 31–61. Dordrecht: Dr W. Junk Publishers.
- Udell MAR, Dorey NR, Wynne CDL. 2010 What did domestication do to dogs? A new account of dogs' sensitivity to human actions. *Biol. Rev.* **85**, 327–345. (doi:10.1111/j.1469-185X.2009.00104.x)
- Nagasawa M, Mitsui S, En S, Ohtani N, Ohta M, Sakuma Y, Onaka T, Mogi K, Kikusui T. 2015 Oxytocin-gaze positive loop and the coevolution of human-dog bonds. *Science* **348**, 333–336. (doi:10.1126/science.1261022)
- Miklósi Á, Kubinyi E, Topal J, Gácsi M, Virányi Z, Csányi V. 2003 A simple reason for a big difference. Wolves do not look back at humans, but dogs do. *Curr. Biol.* **13**, 763–766. (doi:10.1016/S0960-9822(03)00263-X)
- Freeman GH, Halton JH. 1951 Note on exact treatment of contingency, goodness of fit and other problems of significance. *Biometrika* **38**, 141–149.
- Horn L, Huber L, Range F. 2013 The importance of the secure base effect for domestic dogs – evidence from a manipulative problem-solving task. *PLoS ONE* **8**, e65296.
- Call J, Bräuer J, Kaminski J, Tomasello M. 2003 Domestic dogs (*Canis familiaris*) are sensitive to the attentional state of humans. *J. Comp. Psychol.* **117**, 257–263. (doi:10.1037/0735-7036.117.3.257)