



## FORUM

## Ontogeny's impacts on human–dog communication

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Several authors have argued recently that domestication has led to a special sensitivity to human social cues in domestic dogs, *Canis familiaris*. This sensitivity is not present in dogs' closest wild relatives and progenitors, wolves, *Canis lupus* (Hare et al. 2002; Kubinyi et al. 2007). Furthermore, even puppies too young to have had extensive exposure to humans are able to follow human social cues. Consequently this ability must have a largely innate basis (Hare & Tomasello 2005; Hare et al. 2005). Various forms of cueing the location of hidden food by a human pointing with her limbs have been extensively used as tests of canid comprehension of human intentions (e.g. Miklósi et al. 1998; Hare & Tomasello 1999; Udell et al. 2008; reviewed in Udell & Wynne 2008).

In a recent paper Riedel et al. (2008) presented data from four age groups of puppies, ranging from 6 to 24 weeks, which, they claimed, indicate that 'dogs as young as 6 weeks old can use a variety of human communicative gestures to locate hidden food'. They believe this 'suggests that dogs do not acquire these skills mainly because of their experiences in ontogeny' (Riedel et al. 2008, page 5).

We believe that the results presented by Riedel et al. (2008) do not justify their conclusions. We concentrate our analysis on their experiment 1 because it is the only experiment that tested several different juvenile groups (experiments 2 and 3 compared only young dogs to adults), and it included three different types of point (experiments 2 and 3 presented only one type of point each) and thus three times as many trials as the other two experiments.

In experiment 1, 16 puppies at each of four different ages (i.e. 64 dogs in total) were tested on three different types of point and a control condition. The ages tested

were 6, 8, 16 and 24 weeks, and the points were Dynamic cross point move (DCPM: experimenter pointed to baited cup with index finger of contralateral hand four times, leaving her hand indicating the cup), Dynamic cross point (DCP: as DCPM but pointing only once) and Marker (M: experimenter placed a piece of wood on top of the baited cup in full view of the dog). In addition, all dogs were tested on control trials in which a cup was baited but no cue was offered.

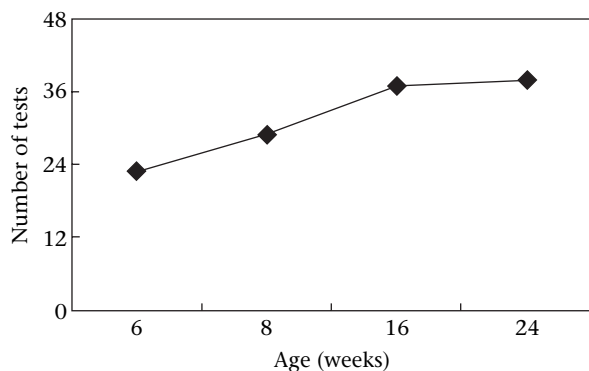
In each case, the oldest dogs performed better on each point type than the youngest dogs. The oldest dogs scored 0.63, 0.81 and 1.19 points better than the youngest on an eight-point scale on the three conditions, DCPM, DCP and M, respectively. Since chance was 50%, the portion of the range over which the dogs' performance might vary is only four points: thus these improvements are from 16 to 30% of the portion of the scale over which they might plausibly vary. Riedel et al. (2008) reported, however, that this improvement with age was not in general statistically significant. They analysed the results with a mixed-model ANOVA with condition (point type) as a within-subjects factor and age group as a between-subjects factor. Although the main effect of age was significant ( $F_{3,60} = 2.85$ ,  $P = 0.045$ ), Riedel et al. (2008) did not consider this evidence of an effect of age on the experimental performance because their analysis included the control condition. Since there were no cues offered in the control condition, performance on it should not improve with age and thus, in this analysis, an effect of age in the experimental conditions would show itself in the interaction of age with condition. This analysis, Riedel et al. (2008) reported, is not significant ( $F_{3,180} = 1.59$ ,  $P = 0.12$ ). Follow-up Bonferroni-corrected one-way ANOVAs on the performance on each condition separately revealed a significant effect of age for the Marker condition ( $F_{3,60} = 4.23$ ,  $P = 0.0009$ ), but not for the other two experimental conditions.

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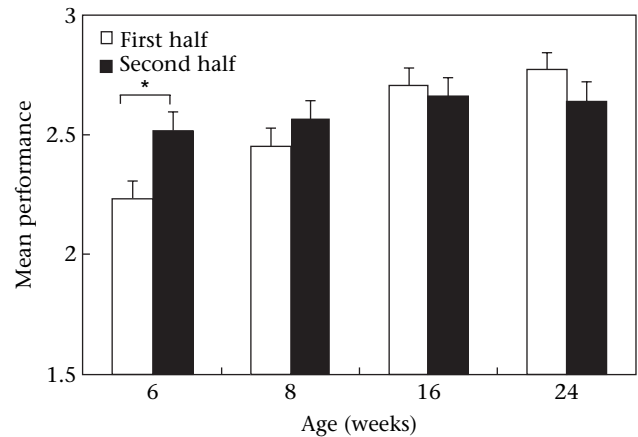
We propose that the lack of statistical significance for the other two conditions is due to a lack of power in the ANOVAs. Since there is no expectation or evidence that the dogs improved on the control trials on which no point was offered, that condition can be omitted from the analysis. In this way, the sought-after effect becomes a main effect (of age) instead of an interaction (of age and condition) and thus has greater statistical power. We repeated the analysis, using the data in Riedel et al.'s (2008) Table 1, with the within-subjects factor experimental condition and the between-subjects factor age. We found that there was a significant effect of age ( $F_{3,60} = 3.73$ ,  $P = 0.016$ ), as well as of experimental condition ( $F_{2,120} = 21.50$ ,  $P = 0.000001$ ). The interaction of these two factors was not significant ( $F_{6,120} = 1.15$ ,  $P = 0.338$ ). Thus it is safe to reject the null hypothesis that there is no difference in the performance of the subjects of different ages in following human points.

We also considered the performance of the individual dogs. In their Table 1, Riedel et al. (2008) included those occasions on which individual dogs reached a criterion of seven of eight trials correct for a given condition. Seven of eight trials correct has a binomial  $P = 0.035$ . Figure 1 clearly shows that the number of individuals reaching a statistically significant level of performance increased monotonically with age. At 6 weeks, dogs performed significantly above chance on fewer than half the tests: at the oldest age they were above chance on more than three-quarters of the tests.

Riedel et al. (2008) also claimed that the dogs did not improve in performance over the course of each session of testing. They supported this argument with a mixed-model ANOVA comparing the first and last four trials of each experimental condition (within subjects) with age as a between-subjects factor. Again we propose that the failure of this analysis to produce a statistically significant result is due to insufficient power. To increase power (and to avoid an analysis of binary data, which do not fulfil the prerequisites for an ANOVA) we summed across experimental conditions. As Riedel et al. (2008) referred to the three conditions as interchangeable tests of the ability to follow human cues, pooling their results seems reasonable. We compared the first half to the second half of each dog's testing. This split-half analysis showed no



**Figure 1.** Number of tests on which individual dogs scored more than seven of eight trials correct (binomial  $P = 0.035$ ). Data from Riedel et al. (2008), Table 1.



**Figure 2.** Mean number of correct responses (out of three) of dogs over three experimental conditions at four ages during the first 12 and last 12 trials in the experimental conditions of Riedel et al. (2008). Error bars show 1 SE. \* $P = 0.025$ .

main effect of session half ( $F_{1,252} = 1.17$ ,  $P = 0.281$ ) but did show a significant main effect of age ( $F_{3,252} = 6.84$ ,  $P = 0.001$ ) and a significant interaction of session half with age ( $F_{3,252} = 3.16$ ,  $P = 0.025$ ). Performance increased across the session halves for the youngest age group, but not for the older age groups (Fig. 2). This indicates that the older age groups had fully learned to use the cues prior to the experiment, but that the youngest age group was still learning to respond to the human cues during experimental testing.

Our reanalysis of the data clearly shows that performance of the puppies on the tests involving human cues improved with age from 6 to 24 weeks. Furthermore, the youngest age group of dogs improved in performance from the first to the last half of each test session.

Riedel et al. (2008) stated that, to test whether the responsiveness of dogs to human social cues is due to domestication or socialization, it is necessary to test puppies, 'with limited or no human contact' (page 2). They pointed out that 'Freedman et al. (1961) showed that at 7 weeks of age puppies are most receptive to socialization with humans' and thereby justified their choice of puppies 'from 6 weeks on' (page 2) as a suitable group in which to demonstrate a minimal impact of ontogeny.

The argument that the youngest dogs they tested had not reached their 'most sensitive period of socialization with humans [and] thus... human interaction and influence on their behaviour was reduced to a minimum' (Riedel et al. 2008, page 5) is weak. Riedel et al. (2008) failed to take into consideration that when Freedman et al. (1961) identified 7 weeks as the point of maximal responsiveness to humans, they were studying minimally socialized pups that experienced human contact only for three half-hour periods a day during a single week of their lives. This week took place between 2 and 9 weeks of age. It is under those highly constrained conditions that the 7th week proved to be the period of maximal receptiveness to humans. In fact, the most plastic portion of social development for the dog is between 4 and 8 weeks (Scott & Marston 1950; Scott 1958; Freedman et al. 1961), the

time period when dogs' sensory systems are fully developed but fear does not yet inhibit exploration (Freedman et al. 1961; Fox 1965; Scott & Fuller 1965; Rosenblatt 1976).

For the group of dogs to be considered as having minimal exposure to humans, Riedel et al. (2008) would have had to offer evidence that the pups under test had indeed experienced minimal human social interaction. The dogs, however, are described as privately owned in an urban environment.

Furthermore, pups raised by a breeder usually begin to receive supplemental gruel feeding by hand at 4 weeks of age. Thus, by 6 weeks, even though they have not yet been weaned, most pups reared in a home have had 2 weeks of experience of hands being associated with food. Given standard practice when breeding dogs as pets, we think the burden of proof was on Riedel et al. (2008) to show that these puppies had not received repeated interaction with humans, such as might make human limbs into stimuli predictive of the location of food, toys and other significant stimuli.

Many studies assume that if they use only a small number of trials (in Riedel et al.'s 2008 case, eight on each of three point types), then learning to follow the cues during the test sessions is unlikely. This assumption overlooks how readily pet dogs can be trained. Each 'test' trial in experiments of this kind is rewarded if correct and nonrewarded if incorrect and thus constitutes an operant training trial. Udell et al. (2008), in a study of dogs' following of human points, found evidence of learning within 10 trials. Several reports indicate very rapid learning of other human signals in domestic dogs. McKinley & Young (2003) found that pet dogs could be taught a new vocal label in around 8 min. Bentosela et al. (2008) reported that just three training trials were sufficient to increase pet dogs' rate of gazing towards an unfamiliar human's face.

We contend that a behaviour as complex as extrapolating the angle formed by the limbs of an individual of a different species to locate hidden food cannot possibly develop essentially independently of experiences in ontogeny as Riedel et al. (2008) and others have claimed. For the performance to develop, certainly an individual must possess the appropriate genetic substrates. Equally clear, however, is that appropriate ontogenetic conditions must be fulfilled. These include accepting humans as social companions, which is a product of exposure to humans during a critical developmental window (Coppinger & Coppinger 2002). No test has been published on the response to human points of nonhuman-habituated dogs for the simple reason that no experimenter could get close enough to such a dog to carry out the test.

Acceptance of humans as social companions, however, is not sufficient to follow human limb points 'spontaneously'. M. A. R. Udell, N. R. Dorey & C. D. L. Wynne (unpublished data) found that dogs at an animal shelter do not follow points, even though the dogs they tested readily accepted humans as social companions. A dog must have experience with desired objects becoming available from human limbs if it is to follow those limbs to find such objects.

To isolate the different kinds of experience that are necessary for a dog to show responsiveness to human social cues, a study of the ontogenesis of dogs' ability to follow human points needs to differ in several ways from Riedel et al.'s (2008) experiment. First, to test the importance of exposure to humans as social companions, it needs to include a group raised in isolation from humans until the time of test. Second, to test the impact of experience with human hands delivering important consequences, a group needs to be raised such that, although they accept humans as social companions, they have no (or minimal) experience of human hands delivering consequences. This might be difficult to implement, but the fact that pound dogs do not follow points (Udell et al., unpublished data) suggests that it may not be essential that the dogs have absolutely no experience of human limbs offering food for them to fail to follow points. Finally, a study of this type should use a more difficult form of pointing, such as the momentary distal point, so that improvement within sessions, if present, is more obvious.

Such a study, delineating the specific ontogenetic factors that contribute to the dog's ability to follow human social cues such as points, would be a valuable contribution to our understanding of the human–dog relationship.

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